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£60,000!

WE have seriously put to ourselves the question whether it is worth while to make further reference to the "Eclipse" battery—whether there is any need that we should devote more of our space to consideration of so insignificant a contrivance. Notwithstanding the peculiar nature of our experiences, we have some little faith left in the bulk of humanity, and are not disposed to write all men down as senseless, nor even so large a proportion of them as the cynical Carlyle would have had us do: therefore our doubt whether the hollowness of the pretensions made respecting this latest claimant to the possession of wonderful qualities was not sufficiently self-evident. But we recollect that it is impossible that the great mass of human beings of all grades and orders which forms the British public can be completely informed upon every minute topic, and that it is our duty, in our own special province, to accord it what aid soever it may be in our power to render. A difficulty meets us here, however, in the probability that those who will read our advice will not need it, while those who most require it will remain in utter ignorance of the fact that it has been offered them. It is so much easier and more convenient to get all one's thinking and discovering done by another, and each constituent element of "the public," with very few exceptions, turns for guidance in most matters to some person or periodical whom or which it believes to be an authority or a leader of thought and opinion. How implicitly, for instance, do many people put their faith in the utterances, no matter whether on political, social or scientific subjects, of some one newspaper. That paper may be fully entitled to speak with the voice of authority upon certain more or less important questions of the day, but it usually pronounces with an assumption of assurance, an air of knowledge, upon every matter with which it condescends to deal, and the general reader who brings a perfectly open and uninformed mind to its perusal is pretty sure to fall into the same way of thinking. If these habits—those of the newspapers and those of the readers of them—were exercised only in connection with politics or with those questions to which the term social is usually applied, we should have very little ground of complaint; but unfortunately the reader is too strongly inclined to think that his oracle must necessarily be as right in its judgments concerning things of which he is ignorant as in those upon subjects regarding which he presumes to form an opinion of his own, so that when scientific or technical questions are dealt with he accepts unquestioningly the dictum of his newspaper. It is for this that we blame the public—for not assuring itself that its guide, philosopher and friend is a properly instructed leader, for not putting itself to the pains of finding out whether it is consulting the right authority when it desires information upon special subjects. But even though the public is guilty of this folly, our duty is clear, and we warn it to be guarded in its relations with the "Eclipse" battery shares.

In the first place we would have it clearly understood that we do not say that the battery may not be, as primary batteries go, a fairly good one. That there is anything strikingly new or advantageous in it, however, we unhesitatingly deny. Last week we made brief reference to the specification of one of the patents relating to the battery. That specification was No. 4,744 of the present year and related to "improvements in means for supporting or suspending elements in electric batteries," and it described a method of suspending the zinc element upon a copper hook inserted at its centre. The inventor appears to suppose that this arrangement will prevent local action in the battery and decrease the internal resistance; but it seems to us to be an effective means of causing local action both when the battery is in operation and when it is inactive as regards the performance of work outside itself. The other patent for which, in conjunction with No. 4,744 of 1887, the trifling sum of £60,000 is asked, is No. 8,228 of 1885, which describes the construction of the battery generally in these words:—

"A wooden box, six inches square by six inches deep, is divided by vertical partitions into four compartments, forming four cells of equal capacity, and the inner sides of the said cells are coated with paraffin, or other suitable substance, in the usual way. A porous cell, five and a half inches long by one and a half inch diameter, provided with a flange or foot at the bottom, is placed in each wooden cell, and paraffin being poured into the bottom of the cell holds the said porous cells firmly in position, so that the battery may be inverted without affecting them. The battery is provided with a wooden cover, faced with sheet India rubber and held down by bolts and nuts, or other suitable devices, and the tops of the porous pots being flush with the tops of the wooden cells the various compartments and cells are effectually sealed. Four carbon rods, five inches long by three-eighths of an inch diameter, are held firmly by one end in holes in the said cover and enter the porous pots, and four brass screw clips, also affixed to the cover, hold zinc cylinders two inches diameter by four inches deep, which dip into the wooden cells and surround the porous pots. The battery is charged with the following ingredients: eight parts of sulphuric acid are added to eight parts of water, and sodium nitrate is dissolved to saturation therein, one part of potassium bichromate is then added, and the resulting solution is placed in the porous cells. The outer cells are charged with one part sulphuric acid to sixteen parts of water."

This, then, is the marvellous invention for which the public is asked (in vain, we hope) to subscribe the modest sum of £60,000: an ordinary voltaic battery, the constituent elements of which are zinc,

carbon, sulphuric acid, water, and nitrate of soda. The combination of these elements will no doubt result in the production of a very useful amount of current; but unfortunately it is by no means certain that it is the best combination that has been devised, and even as it stands it is not new, for, as our readers will no doubt have learnt from a letter which appeared in our columns last week, patents were previously in existence covering the use of nitrate of soda with sulphuric acid.

Prof. Silvanus Thompson is made to act—against his will so far as the extended publicity accorded to his remarks are concerned, we imagine—as a sort of special pleader on behalf of this battery. No doubt he is right in suggesting that there is an advantage in being able to direct the light, when the battery is used, in connection with an incandescent lamp, for mining purposes, upwards as well as sideways; but does he really intend that the inference shall be drawn, that with no other electric miner's lamp is this possible? Does he mean us to believe, too, that there are no other batteries which will run for thirteen hours without re-charging, and none so little likely as the "Eclipse" to cause an explosion? It is greatly to be feared that the effect upon the public mind of Prof. Thompson's no doubt perfectly truthful statements, will be to create the belief that the Eclipse battery stands alone in the possession of the qualities and advantages to which he directed attention.

Electrical engineers are beginning to regain a little of the public confidence which was snatched from them in consequence of the misdeeds of unscrupulous promoters, and it would be a grievous pity that their reputation should once again be endangered and electrical industries retarded as the result of this endeavour to foist upon the public a so-called invention, which, instead of being worth sixty thousand pounds, would be far too highly valued at a small fraction of that sum. To some extent it is in the power of the profession to render exceedingly difficult, if not altogether impossible, the practice of such exploits as these, and we would suggest that when opportunity offers they should lend us their aid in exposing them by sending us timely information, and by themselves publicly protesting against that which is known to be more or less worthless.

IT is almost amusing to read in *Industries* that as a result of Mr. Reckenzaun's experimental trips in Philadelphia (mentioned in the REVIEW for July 15th), the system of propelling tramcars by means of the current from secondary batteries placed in the cars themselves is beginning to attract attention at Vienna. Is it possible that electricians in Vienna have now heard for the first time of Mr. Reckenzaun and his work? that the news of the trials at Kew some years ago, and of those at Battersea in 1885, has not penetrated to the native land of the foremost exponent of the secondary battery system? This would really seem to be a further justification of the proverb respecting the prophet and his own country, for it is only now that they hear of him apparently as of a stranger, that they recognise any merit in his projects. It is probable, the correspondent of our contemporary tells us, that one or other of the many proposed lines in Austria will be worked by storage batteries.

A PASSAGE in this week's contribution to our series of articles on the "Evolution of the Electric Telegraph" has set us thinking once more on what looks like the degeneracy of our leading newspaper. The passage is that in which it is recorded that Dr. Booth, who lectured on electricity and magnetism in Dublin, in 1830, was a scientific reporter for the *Times*. Why does not the *Times* still retain "scientific reporters" deserving of the name upon its staff? It has been with pain that we have from time to time drawn attention to the singular utterances of our great daily contemporary upon electrical subjects, for we regard the *Times* almost as a national and representative institution, and observe any signs of its failing to justify its enviable reputation with great regret.

WE have to deplore a serious accident which has occurred in Montgomery, Ala. A horse was there killed, on the 25th of last month, by an electric shock administered by the falling of a wire which formed part of the electric street car system. An accident of this kind, which is as likely to cause the death of human beings as of horses, does more to retard the progress of electric locomotion than years of strenuous advocacy by those who believe in its safety and practicability can do to promote it. There must, we should think, have been great negligence to have rendered it possible for a highly charged wire to fall into a crowded thoroughfare. Electricians should insist upon the most substantial and thorough methods of construction in every part of their systems, no matter whether it be for electric lights or tramcars, so that all possibility of danger may be obviated. Supervision, too, and inspection should be of the most effective order possible. The accident, we may point out, speaks eloquently in favour of self-contained cars with accumulators to provide the electrical energy. Grave doubts have been expressed as to the life of any secondary battery now in the market when exposed to the shaking and hard usage which electric locomotion demands. We have ourselves recently been witnesses of the sad havoc which certain well-known types of these cells have sustained when applied to this class of work. There are, however, we believe, instances in which secondary batteries have been specially constructed for withstanding the rough treatment entailed in tramway work, and next week we hope to be able to present to our readers a form of battery which, to our mind, meets the needs of electric locomotion in a manner which has not hitherto been thought possible.

ONE often reads in technical journals and elsewhere of experiments with electric cars, but seldom do we see reliable data published concerning them. As a rule people who carry out tests do not trouble themselves much about exact measurements, and as for putting accurately calibrated instruments in the car, nobody thinks of it. We have conversed with electric tramway men, both European and American, concerning the amount of energy consumed by a car under the varying conditions of particular lines, but few know anything of a definite nature on this point beyond the mere approximation of horse-power applied at the generating station. It is of the utmost importance that we should know exactly the available power on the car itself: how much is necessary on the level road, in starting, on grades and around curves. Hence the necessity of

getting exact measurements of the capacity of the motor when off the car with all sorts of loads, and when the car is in motion, but this can only be done by a systematic method of operations. The procedure should be as follows :—Assuming that the motor is of sufficient power to satisfy the maximum demands that are likely to be put upon it in the particular case under consideration, it should be placed upon a rigid platform and a pulley of suitable dimensions fixed to one end of the armature shaft upon which to apply a Prony brake. On a separate table, and at a short distance from the motor, a carefully calibrated voltmeter and ampèremeter should be placed, capable of measuring the greatest current and E.M.F. that the motor is capable of utilising, and suitable switches to throw the instruments in and out of circuit must be attached to the table in such a way as to enable the observer to have full command over them when about to take readings. One man can attend to both instruments with a little practice, and a second operator can take the revolutions with a speed indicator and attend to the watch also. A third is required to manipulate the Prony brake, which demands a certain amount of skill, but this can readily be acquired. He gives the signal to the man holding the watch directly his brake lever is properly balanced, and this individual calls out at the time when the observations on the measuring instruments are to commence and to finish. Generally a satisfactory test can be made by skilled operators in half a minute, but at times it may be more advisable to extend the interval to one minute. By this means we can obtain a most useful table of observations, to which should be added the calculated electrical and brake horse-powers. It is evident that a given motor will always yield the same mechanical effect with the same E. M. F. and current; therefore, when the machine is afterwards made to drive the car, one can, by observing the E.M.F., current, and speed, read off the corresponding horse-power from the table previously prepared.

WE noted last week, as a matter of surprise to our islanders, that nearly 4,000,000 people in the United States were now being annually carried in cars propelled by electricity. We understand that the Elieson cars average 7,000 passengers per week, so it only requires that twelve of these should be in regular work to surpass the result above given, and it is to be hoped that we shall shortly see this accomplished in the metropolis alone. We may add that the two Elieson cars are still making satisfactory progress and that arrangements are being made for running a third at the earliest possible date.

AS an instance of the ease with which experiments on electric locomotion can be carried on in America, we are informed that in Philadelphia, for example, vehicles of any kind may be propelled over any of the numerous tramlines without asking the permission of anybody, so long as other traffic is not impeded, or life and property endangered. Neither Board of Trade, vestries, police, nor even the tramway companies whose lines are thus utilised can interfere so long as no fares are taken, which would, of course, mean interference with the rights of others. What a contrast to the immense and almost unsurmountable difficulties which have to be encountered in England and elsewhere! Naturally, as a matter of courtesy, the owners of the electric car would inform the directors of any particular company of their desire to utilise certain lines for the necessary trials, and they are usually met in the most friendly spirit.

AN esteemed contemporary has fallen foul of the electric light as applied to coast towers and lighthouses in rather an extravagant manner. First complaining that modern navigators must be inferior to the ancients if they need 40-mile indicators, the *Liverpool Journal of Commerce* expresses its fearfulness that in process of time there will be a demand for extreme distance lights, and that, as all methods of illumination must fail in unfavourable conditions of the elements, the next step will be the trebling of all coast lights. Having conjured up this bogey of extravagance, the *Journal* proceeds to point out how useless, and worse, this multiplication of lights would become, inasmuch as "all distinguishments in lights will be destroyed by the rays blending, or extinguishing the flashes or colours." We do not think our contemporary need fear that any lighthouse authorities, or any other persons having a voice in the matter, will ever consent to the increase to so alarming an extent as it seems to fear of coast lights, whether electric, gas, or oil. As to the comparison of modern with ancient navigators, the conditions have so completely changed that what was amply sufficient in the way of guiding lights for the needs of the crawling sailing vessels of olden times is utterly inadequate for the rapid-travelling steamships of to-day. Then, can our contemporary assure us that there were not many unrecorded wrecks in the years before the existence of the telegraph and newspaper, due entirely to the lack of coast lights?

IN the same article the *Liverpool Journal of Commerce* comments upon the paper of Mr. Stevenson, read at the recent meeting of the Institution of Mechanical Engineers, respecting the electric light on May Island, and we think there is probably some cause for its adverse remarks as to the elevation and position of the light, although we cannot be expected to concur in all its exaggerated views. "The approach to the Firth of Forth," says the *Journal*, "is now marked by a glistening star stuck high up in the sky, which has to be deflected and doubled in thick weather by the operation of a second steam engine. Oil or gas would have accomplished every necessary purpose; but the shipping interest must be taxed to pay for a costly machinery producing a dazzling light which hinders a navigator from seeing harbour or leading lights beyond, and which creates a false appearance as to distance. Mr. Stevenson declares that the Scotch can now say they possess the most powerful light in the world. That may be a triumph in engineering, but the value of a light should be estimated in fogs, and to be of service in thick weather the towers should not be so outrageously elevated. The nearer the light is to and along the surface of the sea the more useful it must be to mariners." We should like to have the opinions of those of our readers who have had an opportunity of judging as to the correctness of these assertions.

THE report of Mr. Holroyd Smith on the defective arrangements which have been allowed to exist in the Blackpool electrical tramline will be read with feelings akin to those produced upon one's risible faculties when immersed in Mark Twain's or Bret Harte's comicalities. The method of testing for faults by treating the whole system to a cold sea bath, and then warming it up until it all ends in smoke, is both original and simple; and we scarcely know which is the more amusing, the actual test or the gravity with which Mr. Smith questions the prudence of the course adopted.

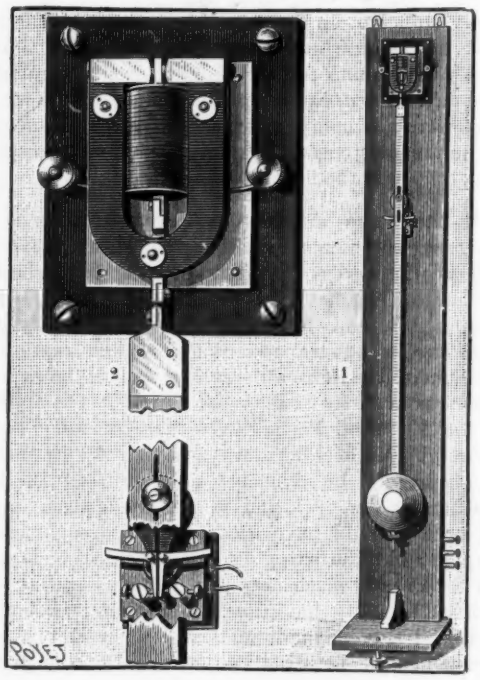
CARPENTIER'S ELECTRICALLY MAINTAINED PENDULUM.

THE keeping up of a pendulum consists in restoring to it, in proportion as it loses, the energy absorbed by friction with the air, and resistances of suspension, so as to keep constant the amplitude of its oscillations; the electrical working of it means drawing from some electrical source the energy required.

In order to transmit to a pendulum each supply of restored energy, it is necessary to adopt a system entailing the least possible disturbing influence on the law of its movement, and one in which the action is independent of the intensity of the electrical current employed.

The method employed by M. Carpentier, and described in *La Nature*, is shown in the accompanying figure, both in its complete form and with the details of the mechanism, and it consists in slightly displacing periodically the point of suspension of the pendulum horizontally and in the plane of the oscillations.

For this purpose the pendulum rod is suspended by means of a very thin and flexible blade of steel, dovetailing into the movable armature of a kind of polarised



relay, forming part of the framework of the pendulum itself. Under the influence of an electric current periodically reversed, the armature of the relay oscillates between two stops, the distance between which can be reduced at will, and draws the point of suspension first in one direction and then in the other, thus keeping constant the amplitude of the oscillations.

This method is really merely an imitation of what we are led to do when, holding in the hand a cord at the extremity of which is supended a heavy body, we endeavour either to generate or to keep up the oscillations of this improvised pendulum. It was some time ago applied by M. Guilmet to a time-piece invented by him, in which the displacement of the point of suspension is effected mechanically by the spring action of the clockwork.

The displacement of the point of suspension takes place perpendicularly by the action of the weight; its extent does not depend on the intensity of the current working the relay.

The periodical reversing of the current is effected by a commutator placed on the wood that serves as a framework to the pendulum, and actuated by the pendulum itself. It is due to the reciprocal action exercised from a distance between a small magnet fixed to the pendulum rod, and drawn along by its movement, and a piece of iron belonging to the commutator. The latter is in the form of the arc of a circle, the centre of which coincides with the axis of suspension of the pendulum, thus the magnet or the pendulum rod moves opposite to it, without any variation in the small distance separating them. The arc of iron is mounted in the middle on an axle placed in the symmetrical plane of the apparatus, and whilst the point of application of the attraction that it undergoes from the magnet passes alternately from one part to another of the articulation, we get a series of swinging movements synchronous with those of the pendulum. These movements, limited by stops, are so reduced as to be imperceptible, but they are sufficient by changes of contact to bring about the reversal of the current.

As to the reaction that the pendulum undergoes, it is evident that, being to all intents normal at the iron arc of the commutator, it passes through the suspension which is a fixed point, and that its influence is thus almost eliminated.

Thus we see that the pendulum maintains itself in motion, being completely cut off from all material connection with other bodies. There only exists a magnetic connection between itself and the commutator. This connection no doubt absorbs a certain amount of energy, but the loss in this respect is really inappreciable in comparison with the resistance of the air and those of the suspension. In systems where the commutation is effected by mechanical means, the reverse takes place, and the working of these organs is the main cause of stoppages, for really the pendulums in such systems require at each oscillation a much greater reinforcement of energy than this one. Now, if this restoration has a disturbing influence of the law of movement of the pendulum, is not the reduction of it an advantage?

To give an idea of the result at which the inventor has arrived, it is sufficient to remark that this pendulum is kept at work by means of a displacement of the point of suspension amounting to 0·02 millimetres at each oscillation.

Without entering into an examination of the possible applications of this apparatus, we may remark that for the distribution of the time in towns, it fulfils a condition generally required, the emission of a current periodically reversed.

ROYAL JUBILEE EXHIBITION, MANCHESTER.

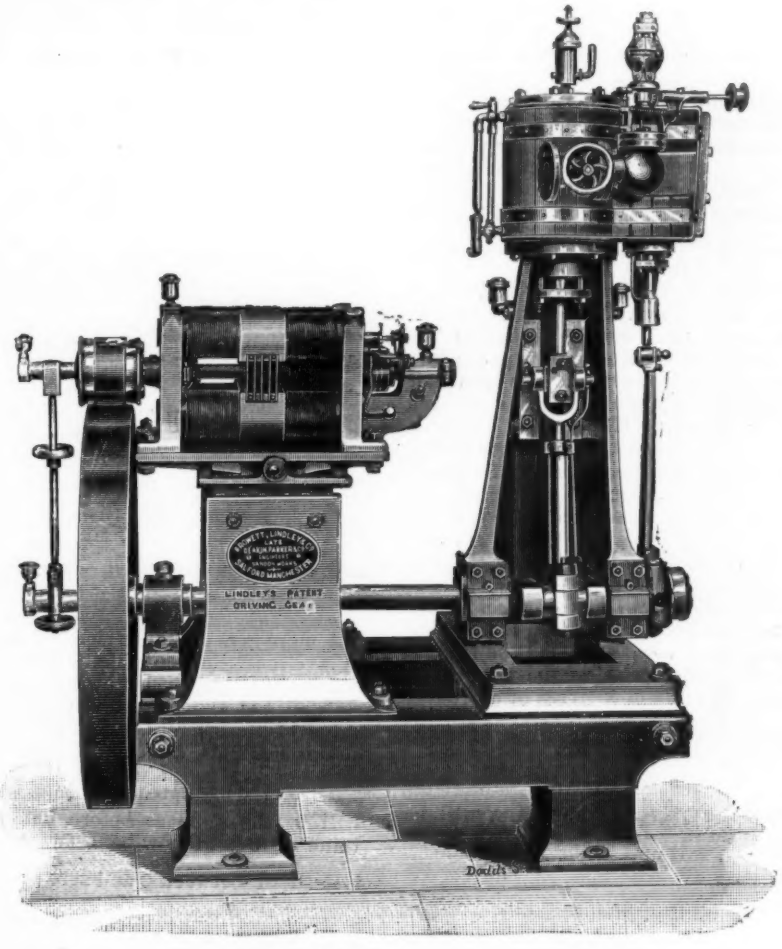
EXHIBITS.—DYNAMO DRIVING.

OF the motive power used in the dynamo room for driving the various machines used for the lighting of the exhibition, there is no need of any mention other than that which we have already made in previous articles; in each case of engine and dynamo, the power has been transmitted by belting with intermediate shafting, except in the case of the engines employed for lighting the Fine Arts Section. In this case, as well as in a pair of diagonal engines used for driving a generator, Messrs. Mather and Platt use a short strap of special construction in connection with their particular arrangement of "jockey" pulley. We purpose giving details of this arrangement, but postpone them for a time until the results of the working of these new type engines have been obtained, when the power absorbed by the pulleys can be verified. Whatever advantage may be claimed for the use of a "jockey" pulley, there is a disadvantage in the fact that a certain amount of power is consumed.

The various motors throughout the exhibition which we mentioned in our last issue as driving dynamos consist of steam, coal gas, and petroleum engines, but there are several steam engines driving dynamos which we have left unnoticed, for the reason that they do not drive by belting nor by rigid coupling, but by friction gear, an arrangement, which, from its compact-

ness and facility for throwing in and out of gear, has come very much into use on board ship, where these points are very essential, from the limited amount of room usually provided.

At stand 518 in the Machinery in Motion Section, Messrs. Browett, Lindley & Co., of Salford, show several of their special electric light engines, both simple and compound, and one to which we specially refer and herewith illustrate. This engine is in combination with a dynamo, and, as may be seen, forms a complete and compact electric lighting plant mounted on one bed. The engine is one of their 4 H.P. vertical engines combined with one of the Anglo-American Brush Corporation's "Victoria" dynamos, B_2 size, for 80 20-C.P. lamps. The dynamo is driven at 1,350 revolutions (the engine running quite steadily at 250 revolutions), by Lindley's patented form of the Raworth friction driving gear.



In our illustration the above combination is shown, but it is necessary to point out that the woodcut is taken from a smaller set, and since its production several important details have been improved. In the combination exhibited in motion at the exhibition—which is utilised to light up about 30 incandescent lamps arranged as a fringe to the exhibitor's signboard—the side frames which support the table on which the rockers ride, are carried nearer to the end of the dynamo so as to provide a rigid body to receive the side thrust due to the driving strain, an arrangement which keeps the dynamo very steady while leaving it free to ride on the rocker in a vertical plane.

The dynamo spindle is fitted with an 8 inch friction bowl whose working surface is made of compressed paper, and the tightening gear for drawing the engine wheel and the dynamo pulley into harder contact is arranged so that it also serves to separate their surfaces to throw the dynamo out of gear. The vertical table on which the rockers and dynamo ride is adjustable vertically by a screw, and can then be clamped in position so as to keep the surfaces of the wheel and pulley in fair contact across their whole faces. The bolt, which will be seen as running through the frame at the centre, is simply a safety bolt to prevent the entire unshipping of the dynamo, when the plant is used on board ship, through violent oscillations of the whole.

The entire plant runs very smoothly and almost silently (a qualification very essential for a yacht) and the speed is well controlled and also capable of adjustment by the "Acme" governor fitted to the engine. The general construction is such that any type of dynamo can be very easily mounted on two rockers and placed on the table, and the dynamo is at a very convenient height for manipulation, being also very free of access. The facility for throwing the dynamo in and out of gear whilst the engine is in motion is all that can be desired, and the regulation of the steam by the "Acme" governor is particularly good (this governor is a patent of Mr. Lindley's and deserves a special description). The regularity of working and freedom from noise and vibration have been observed by ourselves frequently when examining this electrical plant. Messrs. Browett, Lindley & Co. claim for their arrangement the advantages of great compactness and simplicity, together with durability and cheapness; to the former we can bear testimony, as well as to the facility for throwing in and out of gear whilst in motion, and the perfect steadiness of working. We may add that the work is excellently finished and the combined arrangement of dynamo and engine with friction driving gear forms a most compact and highly practical exhibit.

At the stand of the Anglo-American Brush Electric Light Corporation, several examples of the Brush engine driving Victoria dynamos with the friction pulley of Mr. Raworth (the company's superintending engineer) are shown, as well as a new type of high speed direct acting engine; but as there are several other exhibits at this stand of interest and novelty, we must leave them for a future number.

SELF-INDUCTION AND ITS MEASUREMENT.

By E. C. RIMINGTON.

WHEN the number of lines of magnetic force passing through a circuit varies, an E.M.F. is set up in the circuit due to this variation, and it is equal to the rate of decrease of the number of lines passing through the circuit. Let us consider the case of a simple circuit containing an E.M.F.; when the circuit is closed, the current increasing from zero to its full value given by Ohm's law, must pass through all the intermediate values, and as the number of lines of magnetic force passing through the circuit due to the current in it is at any moment proportional to the current, the number of lines of force passing through the circuit must increase with the current, and their rate of increase will be proportional to the rate of increase of current or to $\frac{dc}{dt}$; let it equal $L\frac{dc}{dt}$; where L is a quantity depending on the geometry of the circuit and on its magnetic resistance. L is known as the "coefficient of self-induction" of the circuit and is equal to the number of lines of force which pass through the circuit when it carries unit current. To consider more fully the value of L, suppose the circuit consists of a coil containing n turns. The current passes n times round it, and as the magnetic field produced by a current is proportional to the number of current turns, the number of lines of force passing through it will be n times as many as if it only consisted of one turn; the circuit is also equivalent to one of n times the area, so that its L will be n^2 times as large as for one turn.

Consider a simple circuit of resistance, R, coefficient of self-induction, L, containing an E.M.F., E. Suppose the circuit to be closed and, at an interval of time, t, reckoned from the instant of closing the circuit, let the current in it be C. The rate of increase of current is $\frac{dc}{dt}$, and the rate of increase of the lines of force through the circuit, and hence the E.M.F. due to the increase of the current, is $L\frac{dc}{dt}$; this E.M.F. will be negative; that is to say, will oppose the E.M.F., E.

We consequently have

$$C = \frac{E - L\frac{dc}{dt}}{R}$$

$$L\frac{dc}{dt} = E - CR$$

$$\frac{dc}{E - CR} = \frac{dt}{L}$$

$$\int_o^c \frac{dc}{E - CR} = \frac{1}{L}\int_o^t dt$$

$$-\frac{1}{R}\log_e \frac{E - CR}{E} = \frac{t}{L}$$

$$\frac{E - CR}{E} = e^{-\frac{Rt}{L}}$$

$$C = \frac{E}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$$

This is the well-known equation giving the strength of current in the circuit at any instant after closing. $e^{-\frac{Rt}{L}}$ can only vanish when $L = 0$, or when $t = \infty$; so that if a circuit possesses self-induction the current can only absolutely attain its permanent value given by Ohm's law, $C = \frac{E}{R}$ after an infinite time, but practically in most circuits $\frac{R}{L}$ is so large that the amount by which the actual current differs from $\frac{E}{R}$, after a very small fraction of a second, could not be shown by any instrument as at present constructed.

$\frac{L}{R}$ is known as the "time constant" of the circuit, and the times that the current takes to attain any given fraction of its permanent value in two different circuits are proportional to their time constants.

If C is required to be a certain fraction $\frac{1}{n}$th of the permanent current, $\frac{E}{R}$, we have

$$\frac{1}{n}\cdot\frac{E}{R} = \frac{E}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$n - n\,e^{-\frac{Rt}{L}} = 1$$

$$e^{-\frac{Rt}{L}} = \frac{n-1}{n}$$

$$\frac{Rt}{L} = \log_e \frac{n}{n-1}$$

$$\frac{L}{R} = \frac{t}{\log_e n - \log_e (n-1)} = \text{time constant.}$$

and $$t = \frac{L}{R}\{\log_e n - \log_e (n-1)\}$$

A more general expression for the growth of current in a circuit can be obtained thus: Suppose that a current of value, C_o, is flowing in a circuit, and that the resistance of the circuit be altered, this will alter the value of the current. Let C be the current in the circuit at a time, t, reckoned from the moment of alteration of the resistance, and let R be the value of the resistance when altered. The differential equation will be the same as before, but the integral for the value of C will now be between the limits C and C_o, instead of between C and zero; also $C_1 = \frac{E}{R}$ where C_1 is the value of the permanent current after the alteration. Then

$$\int_{C_o}^{c} \frac{dc}{E - CR} = \frac{1}{L}\int_o^t dt$$

$$\log_e \frac{E - CR}{E - C_o R} = -\frac{Rt}{L}$$

$$\frac{E - CR}{E - C_o R} = e^{-\frac{Rt}{L}}$$

$$E - CR = (E - C_o R)\,e^{-\frac{Rt}{L}}$$

$$C = \frac{E}{R} - \left(\frac{E}{R} - C_o\right)e^{-\frac{Rt}{L}}$$

$$C = C_1 - (C_1 - C_o)\,e^{\frac{Rt}{L}} \qquad (1)$$

If $C_o = 0$, we have, as before

$$C = C_1\left(1 - e^{-\frac{R\,t}{L}}\right)$$

The current in a circuit may be made zero in two ways; first by making the resistance of the circuit infinite; second by making the E.M.F. acting in the circuit zero.

In the first case $C_1 = 0$ and $R = \infty$, therefore $e^{-\frac{R\,t}{L}} = 0$ whatever be the value of t, and consequently $C = 0$ for all values of t. As a matter of fact, it is almost impossible to make the value of R infinite instantaneously as the break of a circuit is prolonged by a spark at the contact, but by breaking the circuit rapidly we can make its resistance infinite in so short a time that we may regard the effect as instantaneous.

In the second case where R is unaltered, but E is made zero, we obtain a gradual dying away of the current; the equation for it can be obtained from equation (1) by making $C_1 = 0$; this gives

$$C = C_o\, e^{-\frac{R\,t}{L}} \quad \text{and} \quad C_o = \frac{E}{R}$$

if the current in the circuit has attained its permanent value before the E.M.F. in the latter is made zero.

Therefore $$C = \frac{E}{R}\, e^{-\frac{R\,t}{L}}.$$

Again, suppose we have a circuit of resistance, R, with a steady current flowing through it, and we increase its resistance by an amount, r. We should have

$$C_o = \frac{E}{R} \text{ and } C_1 = \frac{E}{R + r}.$$

Therefore

$$C = \frac{E}{R + r} - \left(\frac{E}{R + r} - \frac{E}{R}\right) e^{-\frac{(R + r)\,t}{L}}$$

$$= \frac{E}{R + r}\left\{1 + \frac{r}{R}\, e^{-\frac{(R + r)\,t}{L}}\right\}$$

The curves in the diagram represent graphically the rise of current in a circuit possesing self-induction. They are calculated from the formula

$$C = C_1\left(1 - e^{-\frac{R\,t}{L}}\right).$$

The abscissæ represent the time in hundredths of a second reckoned from the instant of closing the circuit, or the instant the E.M.F. in it commences to act. The ordinates represent percentages of the permanent value of the current. The time constant of the circuit in I. is ·001; in II. ·0036; in III. ·01.

The dotted curve, IV., represents the fall of current if the E.M.F. is made zero after the current has practically attained its full value. The time constant in this case being the same as in curve II.

To find the quantity of electricity which has passed through the circuit at the end of any time, t, reckoned from the instant of closing the circuit.

$$Q = \int_o^t C\,dt = \int_o^t \frac{E}{R}\left(1 - e^{-\frac{R\,t}{L}}\right) dt$$

$$= \frac{E}{R}\int_o^t \left(1 - e^{-\frac{R\,t}{L}}\right) dt$$

$$= \frac{E}{R}\,t - \frac{E}{R}\int_o^t e^{-\frac{R\,t}{L}}\,dt$$

$$= \frac{E}{R}\,t - \left(-\frac{L}{R}\right)\frac{E}{R}\left(e^{-\frac{R\,t}{L}} - 1\right)$$

$$= \frac{E}{R}\left(t - \frac{L}{R}\right) + \frac{E}{R}\cdot\frac{L}{R}\,e^{-\frac{R\,t}{L}}$$

If t be long enough for the current to have practically attained its permanent value $C_1 = \frac{E}{R}$

$$Q = \frac{E}{R}\left(t - \frac{L}{R}\right) = C_1\left(t - \frac{L}{R}\right)$$

$= C_1$ (t — the time constant of the circuit).

If there had been no self-induction in the circuit the quantity which would have passed during the time, t, would have been $C_1\,t$. Consequently the diminution due to self-induction in the quantity passing is equal to C_1 multiplied by the time constant.

Or $$= C_1\frac{L}{R} = \frac{E}{R}\cdot\frac{L}{R}.$$

To find the quantity which passes due to the extra current on making E zero.

$$Q = \int_o^t C\,dt = C_o\int_o^t e^{-\frac{R\,t}{L}}\,dt = -\frac{L}{R}\,C_o\left(e^{-\frac{R\,t}{L}} - 1\right)$$

$$= \frac{E}{R}\cdot\frac{L}{R}\left(1 - e^{-\frac{R\,t}{L}}\right)$$

If t be infinite, or if it be long enough for the current to practically die away,

$$Q = \frac{E}{R}\cdot\frac{L}{R}.$$

The total quantity that passes through the circuit, when the E.M.F. acts for a time, t, t being sufficiently long, and is then made zero, is

$$\frac{E}{R}\left(t - \frac{L}{R} + \frac{L}{R}\right) = \frac{E}{R}\,t.$$

This is the same quantity as would pass if there were no self-induction in the circuit.

To find the work done on starting a current in a circuit.

Let the circuit be closed, and let W be the work done during a time, t, reckoned from the instant of closing the circuit.

$$W = \int_o^t C^2 R\,dt = R\int_o^t C_1^2\left(1 - e^{-\frac{R\,t}{L}}\right)^2 dt$$

$$= C_1^2 R\,t + C_1^2 R\int_o^t e^{-\frac{2R\,t}{L}}\,dt - 2\,C_1^2 R\int_o^t e^{-\frac{R\,t}{L}}\,dt$$

$$= C_1^2 R\,t + C_1^2 R\left(-\frac{L}{2R}\right)\left(e^{-\frac{2R\,t}{L}} - 1\right)$$

$$- 2\,C_1^2 R\left(-\frac{L}{R}\right)\left(e^{-\frac{R\,t}{L}} - 1\right)$$

$$= C_1^2 R\,t + \frac{C_1^2 L}{2}\left(1 - e^{-\frac{2R\,t}{L}}\right) - 2\,C_1^2 L\left(1 - e^{-\frac{R\,t}{L}}\right)$$

$$= C_1^2 R\,t - C_1^2 L\left(2 - \tfrac{1}{2}\right) + C_1^2 L\left(2e^{-\frac{R\,t}{L}} - \tfrac{1}{2}e^{-\frac{2R\,t}{L}}\right)$$

If t be long enough

$$W = C_1^2\left(R\,t - \frac{3\,L}{2}\right) = \frac{E^2}{R}\left(t - \frac{3\,L}{2\,R}\right).$$

To find the work done by the extra current on stopping the current.

$$W = \int_o^\infty C^2 R\,dt = \frac{E^2}{R}\int_o^\infty e^{-\frac{2R\,t}{L}}\,dt = \frac{E^2}{R}\left(-\frac{L}{2R}\right)(0 - 1)$$

$$= \frac{E^2}{R}\cdot\frac{L}{2R},$$

which may also be written

$$W = \left(\frac{1}{2} \cdot \frac{E}{R}\right)^2 . 2L$$

$$= \left(\frac{1}{2} \cdot \frac{E}{R}\right)^2 . R . \frac{2L}{R}.$$

In the same manner

$$W = \frac{E^2}{R}\left(t - \frac{3L}{2R}\right)$$

may be written

$$W = \frac{E^2}{R}\left\{\left(t - \frac{2L}{R}\right) + \frac{L}{2R}\right\}$$

$$= \frac{E^2}{R}\left(t - \frac{2L}{R}\right) + \left(\frac{1}{2} \cdot \frac{E}{R}\right)^2 . 2L$$

$$= \left\{\left(\frac{E}{R}\right)^2\left(t - \frac{2L}{R}\right) + \left(\frac{1}{2}\frac{E}{R}\right)^2 . \frac{2L}{R}\right\} R.$$

This is the same as if the full strength of the current had acted for a time $t - \frac{2L}{R}$ and one of half the full strength for a time $\frac{2L}{R}$.

The total work done in the circuit on closing it for a time t (t being long enough for the current to attain its permanent value); then making the E.M.F. in the circuit zero will obviously be the sum of the last two expressions, that is

$$\frac{E^2}{R}\left(t - \frac{L}{R}\right), \text{ or } \frac{E^2}{R}\ (t - \text{the time constant}).$$

The work done on starting the current may also be found as follows:—

$$W = \int_o^t C\left(E - L\frac{dc}{dt}\right) dt$$

$$= E\int_o^t C\,dt - L\int_o^c C\,dc,$$

since when time is t, current $= C$ and when time is zero current is zero.

If t be long enough $C = \frac{E}{R}$

$$W = \frac{E^2}{R}\int_o^t \left(1 - e^{-\frac{Rt}{L}}\right) dt - L\int_o^{\frac{E}{R}} C\,dc$$

$$= \frac{E^2}{R}t - \frac{E^2}{R}\left(-\frac{L}{R}\right)(0-1) - L\frac{E^2}{2R^2}$$

$$= \frac{E^2}{R}\left(t - \frac{L}{R} - \frac{L}{2R}\right)$$

$$= \frac{E^2}{R}\left(t - \frac{3L}{2R}\right).$$

On stopping the current

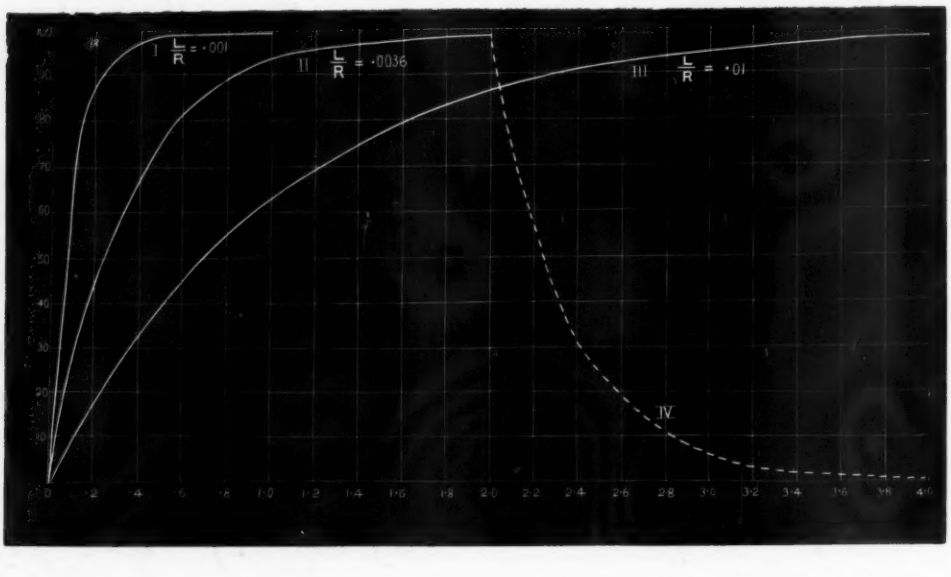
$$W = \int_o^\infty C \cdot L\frac{dc}{dt} \cdot dt = -L\int_{\frac{E}{R}}^0 C\,dc$$

$$= L \cdot \frac{E^2}{2R^2} = \frac{E^2}{R} \cdot \frac{2L}{R}.$$

(To be continued.)

THE ERROR IN THE READINGS OF THE TANGENT GALVANOMETER.

ALTHOUGH in theory the tangent galvanometer is one of the most accurate of measuring instruments, yet, in practice, if care is not taken in the use of the instrument an appreciable error is often introduced.



The two errors peculiar to this instrument are—that due to the size of the needle, and that due to the pointer not pointing to zero when the magnet lies in the plane of the coils. An error also occurs through the friction at the pivot.

If R equals the radius of a coil of the wire, r half the length of the magnet, θ the deflection, and ϕ the angle at the pivot formed by any point in the coil with the horizontal, then the action of $d\phi$ will be proportional to

$$d\phi\, R\left(\frac{1}{(R\cos\phi - r\cos\theta)^2 + R^2\sin^2\phi + r^2\sin^2\theta}\right.$$

$$\left. + \frac{1}{(R\cos\phi + r\cos\theta)^2 + R^2\sin^2\phi + r^2\sin^2\theta}\right)$$

$$= d\phi\, R\left(\frac{1}{R^2 + r^2 - 2Rr\cos\phi\cos\theta}\right.$$

$$\left. + \frac{1}{R^2 + r^2 + 2Rr\cos\phi\cos\theta}\right)$$

If this value is integrated through $\frac{\pi}{2}$ the result will reduce to

$$\frac{\pi R}{\sqrt{(R^2 + r^2)^2 - (2Rr\cos\theta)^2}}$$

and by taking θ at zero and 60° the error with different values of r and R can be calculated.

Thus if R =	4 r	an error of		10	per cent.	occurs.
„ R =	6 r	„	„	5	„	„
„ R =	8 r	„	„	$2\frac{1}{2}$	„	„
„ R =	10 r	„	„	about 1	„	„

so that by making the mean radius of the coils of wire rather more than 10 times the length of the magnet, no appreciable departure from the rule that $c = \tan.\ \theta$ occurs.

The error introduced by the bending of the pointer is greater than is generally supposed.

If the pointer is bent towards the magnet in the direction of the deflection, the deflection will be increased, hence the scale reading exceeds the true reading. If the coils are skewed through angle B and the deflection is a, then the scale reading

$$= \frac{\sin (B + a)}{\cos a}$$

and the true reading

$$= \frac{\sin (B + a)}{\cos (a \pm x)}.$$

Supposing the unit current gives a deflection of K degrees, then the scale reading gives current as

$$\frac{\sin (B + a)}{\cos a} \quad \frac{\cos K}{\sin (B + K)},$$

but the true current is

$$\frac{\sin (B + a)}{\cos (a \pm x)} \quad \frac{\cos (K \pm x)}{\sin (B + K)},$$

and the error would be

$$\frac{\dfrac{\cos (K \pm x)}{\cos (a \pm x)} - \dfrac{\cos K}{\cos a}}{\dfrac{\cos (K \pm x)}{\cos (a \pm x)}}$$

$$= 1 - \frac{\cos K \cos (a \pm x)}{\cos (K \pm x) \cos a}$$

$$= \tan x \frac{\pm \tan a \mp \tan K}{1 \mp \tan K \tan x}$$

where the top signs apply when the bending of the pointer is towards the magnet in the direction of the deflection and the bottom signs when the bending is in the reverse direction.

Thus, if the coils are skewed through an angle of 60° and the constant K = − 19·1°, then the error

$$= \pm \tan x \frac{\tan a + \cdot 3464}{1 \pm \cdot 3464 \tan x},$$

and if the pointer starts from the centre of the scale and K = 34·7°, then the error

$$= \pm \tan x \frac{\tan a - 6928}{1 \mp \cdot 6928 \tan x}.$$

The maximum error in these two cases would occur when $a = 60°$, and would be as follows :—

x	Maximum error per cent.	Skew method. Maximum error per cent.
1°	1·8	3·6
5°	9·7	14
− 1°	− 1·8	− 3·6
− 5°	− 8·6	− 18·7

With care the error x, due to the bending of the pointer, may be made less than 1°, and if it is possible to adjust the scale of the instrument the error may be made very small.

When a number of readings are taken near the same part of the scale the error may be made small by taking the constant as near as possible to the readings.

Thus if the constant, K, is taken at 60° and the readings at 54°, then the error with the galvanometer skewed to 60° is

x	Error per cent.
1	− ·64
5	− 3·7
− 1	+ ·6
− 5	+ 2·7

If the galvanometer is not skewed the errors will be only about half of the preceding amounts.

The error introduced into the readings by the friction at the pivot preventing the needle reaching its true deflection is greatest when the needle lies in the plane of the coils, and becomes less as it becomes further deflected from that plane, since the resultant force of the current with the earth's magnetism then becomes greater. The force with which the needle is directed is (sec a), and therefore the angular error due to friction will be proportional to cos a. If the instrument is skewed the error becomes proportional to (cos a cos B), so that the error due to friction when the instrument is skewed is increased exactly in the same proportion as the deflection. When the instrument is skewed the frictional error will, of course, be greatest at the centre of the scale, that is, at the old zero.

W. MOON.

EVOLUTION OF THE ELECTRIC TELEGRAPH.

(*Continued from page* 140.)

ABRAHAM BOOTH delivered lectures in Dublin in the year 1830 upon electricity and electro-magnetism. In these lectures he used in combination a long circuit of insulated wire conductors, a galvanic battery, an electro-magnet with an armature and mercury cups to join and disconnect the circuit, with which he magnetised and demagnetised the iron of the electro-magnet, causing it to attract the armature when the circuit was made, and to allow it to fall away when broken. The lecturer asserted that the power could be produced and used at distant places as signs of information. Mr. Booth was afterwards a scientific reporter for the *Times*, and eventually became Dr. Booth.

It was in 1830, too, that Prof. Ritchie's first efforts to realise the grand idea of an electric telegraph were made. Ritchie devoted himself to the improvement of Ampère's plan, and on February 12th, 1830, exhibited a model of a telegraph, in which were 26 metallic circuits and 26 magnetic needles, each surrounded by a coil of wire. It was Fechner, of Leipsic, however, who, in the previous year, first suggested the environment of the needle by a coil of wire for the purpose of increasing the deflection effect. In a paper on a torsion galvanometer, Ritchie thus states his views of what might be done in the way of developing his telegraph :—"We need scarcely despair of seeing the electro-magnetic telegraph established for regular communication from one town to another at a great distance. With a small battery, consisting of two plates of an inch square, we can deflect finely-suspended needles at the distance of several hundred feet, and consequently a battery of moderate power would act on needles at the distance of a mile, and a battery of ten times the power would deflect needles with the same force at a distance of a *hundred* miles, and one of *twenty* times the force at a distance of *four hundred* miles, provided the law we have established for distances of seventy or eighty feet hold equally with all distances whatever."

Here we may pause a moment in the record of progress, and note an incident which undoubtedly did much to retard the advance of telegraphy, and to give the project a seeming of impracticability. We have seen how carefully Ritchie framed his surmises in 1830, and his reasons are probably to be found in the experiments of Barlow half-a-dozen years earlier. The

latter stated, as the result of some investigations which he had conducted at the Royal Military Academy at Woolwich, that there was an enormous diminution in the power of a current to produce effects with an increase of distance. It will be interesting, perhaps, to read Barlow's own description of what he observed: "In a very early stage of electro-magnetic experiments," he wrote, "it has been suggested that an instantaneous telegraph might be constructed by means of conducting wires and compasses. The details of this contrivance are so obvious, and the principles on which it is founded so well understood, that there was only one question which could render the result doubtful, and this was, is there any diminution of effect by lengthening the conducting wire? It had been stated that the electric fluid from a common electrical battery had been transmitted through a wire four miles in length without any sensible diminution of effect, and to every appearance instantaneously, and if this should be found to be the case with the galvanic circuit, then no question could be entertained of the practicability and utility of the suggestion above adverted to. I was, therefore, induced to make the trial, but I found such a sensible diminution with only 200 feet of wire as at once to convince me of the impracticability of the scheme." Dr. Jacob Green, of Jefferson College, Philadelphia, in 1827, extended the belief that the effect decreased enormously with the increase of distance, and research in telegraphy was greatly limited in consequence.

The invention of the electro-magnet by Sturgeon in 1825 placed a new and most valuable implement in the hands of the telegraph experimenters. Sturgeon himself does not seem to have utilised his discovery for telegraphic purposes, but Prof. Henry, in America, pursuing the subject of electro-magnets far beyond anything attempted by Sturgeon, not only won distinction by constructing magnets of enormous power, but applied the invention to telegraphy, for which he did *not* obtain the distinction he deserved. This was in the year 1831, when he been engaged upon the development of the electro-magnet for about three years. Prof. Henry worked out the question of resistance in long wires and the intensity of current necessary to overcome that resistance, before Ohm's now universally known laws came to his knowledge, and he thus, as far at least as America was concerned, counteracted the ill effects of the statements of Barlow. It was only by Henry's discoveries that the electro-magnetic telegraph of Morse became possible, and Morse himself, before he became involved in patent litigation, freely acknowledged his indebtedness to Henry. But Prof. Henry, long before Morse's telegraph came before the world, had suggested the application of his electro-magnets to telegraphy, and had even constructed a form of bell telegraph for experimental purposes which answered remarkably well. Henry, however, had for his object "the advancement of science, without any special or immediate reference to its application to the wants of life or useful purposes in the arts." He sought no patents for inventions, and solicited no remuneration for his labours, other than credit for having done what it was in him to do for the promotion of scientific knowledge. He gave freely to the world the results of his researches, and others devoted themselves to the practical applications of the principles which he discovered. Of these were not only Morse in America, but Wheatstone and Cooke in this country. It has been amply demonstrated that these inventors were at a standstill in the early part of 1837 for the want of a means of producing a strong effect at the receiving station. Although Henry had clearly shown the advantage of employing closely-wound coils of fine wire, in 1831 Wheatstone knew nothing, apparently of this, and remained in ignorance until April, 1837, when he was enlightened by Prof. Henry himself, who was then on a visit to this country. We are firmly convinced that Henry did more for the advancement of the telegraph than has ever yet been adequately acknowledged.

Following the reference to Prof. Henry, it is not necessary to do more than mention the researches of Faraday in both electro-magnetism and magneto-electricity. Faraday, as was aptly observed by Professor Gladstone at the Holborn Restaurant on the memorable evening of July 27th, was a discoverer, and left invention to others. He gave the whole of his life to investigation into the principles of natural science and the development of knowledge regarding them; but it is pleasing to be able to record that, while he confined his own labours entirely to the field of pure science, he looked with an approving eye upon the work of those who sought to apply his discoveries and those of other investigators to practical purposes. He was, we learn, the encouraging friend of Wheatstone in that famous inventor's early struggles with the difficulties besetting the path of telegraph experimentation. How far he rendered him assistance by suggestion and advice we shall perhaps never know, but we may rejoice in the knowledge that he did exercise a beneficent influence upon the budding art of telegraphy.

It will be convenient here to deal more fully with the inventions of Baron Schilling, of Cronstadt. In the older accounts in which his work is alluded to many errors are apparent, and the date of his invention is given as 1832. In what we have to say we shall follow Fahie, who, by extended and pretty nigh exhaustive research in this as is in other matters relating to the history of the telegraph, has done more than perhaps any other single individual to elucidate doubtful questions, and to consolidate and render complete our knowledge of the way in which telegraphy has grown from an interesting experiment to one of the most far reaching agencies of civilisation. He in this instance quotes largely from Dr. Hamel, who states that Schilling, while an *attaché* of the Russian Embassy at Munich, saw the telegraph of Sömmering in action on August 13th, 1810. So impressed was he with the beauty and utility of the contrivance that, from that day, electricity and its applications became one of his favourite studies. The impending war between France and Russia led him in 1812 to devise a means of exploding powder mines by means of an electric current across the Neva, near St. Petersburg. At Paris, during the occupation of the allied troops in 1814, he also frequently ignited gunpowder across the Seine. Dr. Hamel vaguely fixes the date of Schilling's first telegraph at about 1825, for he says that the Emperor Alexander (who died on December 1st, 1825), had been pleased to notice the invention in its earlier stage." Schilling's apparatus was based on the property of a voltaic current to deflect a magnetic needle. It is sometimes described as a single needle telegraph, and sometimes as one with five or six needles. The signal-indicating part of the single needle telegraph consisted of a Schweigger multiplier—that is to say, of a magnetic needle, freely suspended, and surrounded by a number of convolutions of insulated wire. The needle was suspended horizontally by a silken thread, to which was attached, parallel to the needle, a little disc of paper, painted black on one side and white on the other. By the deflection of the needle to the right or to the left, according to the direction in which the current moved in the coil, either face of the disc could be shown at pleasure, and two primary signals could be thus obtained, whose repetitions variously combined would represent all the letters of the alphabet and other necessary signs. To attract attention at the receiving station, Schilling in one form of his instrument employed a contrivance similar to the alarum of Sömmering. A clockwork alarum was set in motion by a falling ball striking a lever and releasing the detent, but instead of causing the ball to fall by the accumulation of gas under a balanced spoon-shaped lever as Sömmering did, he suspended the magnetic needle by means of a rigid wire rod, which also carried a horizontal arm, this arm, when the needle was deflected, striking a finely-balanced lever on which the ball rested, and precipitating the ball on to another lever connected with the alarum. At first the currents were transmitted by touching the ends of the line wires (outgoing and returning) direct to the poles of the battery in one way

or another, according to the direction in which the currents were required to flow through the coil. But soon this primitive arrangement was superseded by a simple commutator, consisting of (1) a wooden board having four small holes arranged in a square and filled with mercury, into which dipped, severally, the terminal wires of the battery and the ends of the line wire; and (2) another similar board provided with a handle on one side, and two metallic strips on the other, the ends of which were turned at right angles to the face of the board. They thus formed bridges which were adjusted to dip into the holes of the first board and so establish connection in one sense or another between the poles of the battery and the ends of the line. Instruments constructed upon this principle were exhibited by the Russian Government at the Paris Electrical Exhibition of 1881, together with a model of Schilling's six needle telegraph, the official description of which was as follows:—"This apparatus consists of six multiplier coils, each enclosing a magnetic needle, suspended by a silken thread from a copper support. A little above each needle is placed the paper disc, painted black on one side and white on the other, as in the one-needle telegraph. The sending arrangement consists of a key-board like that of a pianoforte, having 16 keys, in pairs of one black and one white. Each key on being depressed closes the circuit of a galvanic battery, its poles being connected to the lower contacts of the black and white keys respectively. Thus, for example, the negative pole may be connected to all the black keys, and the positive pole to all the white ones. The first six pair of keys are joined to the six line wires (of copper) which are connected at the distant station to the six multiplier coils; the seventh pair serves to work the alarum through its own line wire; and the eighth and last pair is joined to the return wire." In 1830, Schilling went to China, returning in March, 1832, and then again occupying himself with electrical experiments. In May, 1835, he went on a tour through southern and western Europe, taking with him a working model of his one-needle telegraph. At Vienna he engaged in a series of experiments in conjunction with Baron Jacquin and Prof. A. von Ettinghausen, who tried the relative merits of leading the wires over the roofs of the houses and burying them in the earth.

The underground lines were "insulated" by a thin coating of India rubber and varnish, and the leakage was so great that the overhead line easily got the best of the comparison. Later in the same year (1835) Schilling was at Bonn explaining his apparatus to an audience of German naturalists. Prof. Muncke, of Heidelberg, was so pleased with the instrument that he had a model of it constructed for exhibition to his students. The demonstration of the powers of Schilling's telegraph was the cause of a wide-spread interest in telegraphs, and, indirectly, of both Cooke's and Wheatstone's labours subsequently. The Emperor Nicholas conceived an interest in our inventor's project in 1836, and expressed a desire to have a telegraph line established between St. Petersburg and Peterhoff. A commission of enquiry was appointed, and an experimental telegraph set up at the Admiralty; the line being partly of overhead and partly submerged in the canal. The results seem to have been successful, for an Imperial decree was issued in May, 1837, ordaining the establishment of a telegraph to connect Cronstadt with the capital by means of a cable laid along the bottom of the Gulf of Finland. Schilling died, however, on August 6th of that year, and the scheme was abandoned. If the Emperor Nicholas appreciated the value of the telegraph, for Imperial purposes, he took good care that its principles of operation should not become generally understood throughout his realm, for he absolutely prohibited the dissemination of information relating to electric telegraph apparatus even by means of translations of the notices respecting it appearing in the European journals.

(*To be concluded.*)

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 136.)

CALIBRATION OF VOLT AND AMMETERS—(*continued.*)

So far most of the arrangements described have given currents increasing ampère by ampère, the main current being altered by resistance till it is the required number of ampères. In Prof. Fleming's arrangement, which will now be described, the current is altered by a resistance to any approximate value, and this value is measured by means of a potentiometer. The arrangement has frequently been described, so it will be unnecessary to discuss it very fully.

A number of spirals of brass wire are carefully measured and are then arranged on a frame with mercury cups and bars so that any number of spirals can be put in parallel. On moving a handle they are put in series. The resistances are carefully measured separately, and their conductivities are marked. The spirals are arranged so as to give the current required with a convenient fall of potential, and the electromotive force is measured by means of a standard cell and potentiometer. If the resistances heat and thus alter, they are thrown in series and measured. This arrangement has been in use at Messrs. Crompton's works for some time, and works well; it is a little complicated and expensive to fit up, however, but it is easy to work with if the calibration is not done ampère by ampère. A full description of Prof. Fleming's arrangement will be found in *Industries* of last year.

For merely checking an ammeter, as, for instance, when an engineer has bought one and wants to see if it is correct, it would not be worth while to make up complicated resistance frames. The methods by electrodeposition need considerable care, and are not useful unless a chemical balance is at hand.

Fig. 31 shows a simple arrangement for roughly checking an ammeter. The instruments assumed to be possessed are a galvanometer, a standard cell, and a resistance bridge. The current through the ammeter to be calibrated goes through a wire resistance which is made up at random, and this resistance is measured hot just after the current has ceased. Suppose the instrument to be checked reads from 20 to 100 ampères, a resistance is taken which is at least ·075 ohm, so that 20 ampères give 1·5 volts or so. This may be a coil of cable or some iron wire, or an armature of a dynamo machine which is not running. It must be capable of carrying 100 ampères without excessive heating, and it is rather an advantage if it does not lose its heat quickly. This is shown as S in the diagram. As the bridge of the resistance box is not likely to contain a resistance comparable with ·075 ohms, and as contact errors would give trouble if it did, a special resistance must be made up of, say, ·1 ohm. To do this 10 ohms of platinoid wire is measured off, this is cut into ten equal lengths, and these are soldered to two stout copper bars, thus making a resistance of ·1 ohm. If greater accuracy is preferred, ten wires of 1 ohm each may be separately measured. In measuring allowance must be made for the length taken by the soldering. The wire should be so long that the length taken by the solder is inappreciable in comparison, or, say, a quarter of an inch at the end of each piece must be allowed, so that 5 inches are added to the 10 ohms before dividing up, care being taken that the soldering takes up half an inch of each piece. This standard resistance is shown at *w*. The standard ·1 ohm resistance is coupled in series with the large current resistance as shown. In shunt to the large current resistance a potentiometer is arranged. This may consist of a piece of German silver or platinoid wire, and may be, say, 4 feet 2 inches, or 100 half inches long. A scale in half inches can be made of paper and put underneath. The large current resistance is shown in the diagram as if it were stretched along the table; in practice it will probably be some little distance away.

The leads to and from it must then be considered part of the resistance, and the potentiometer must be arranged in shunt to them, also as shown. To take a reading, enough of the cells, F, are put in circuit to give about the reading desired. The contact, A, is touched down till the position is found where there is no deflection, and the position and the reading on the ammeter are noted. The large current is then stopped, and a small current sent through the standard resistance and large current resistance by closing the switch, *f*. The 100 ohm plug is drawn on the left hand side of the bridge. Plugs are drawn till a balance is obtained on pressing the keys. Suppose the balance to be obtained with 77 ohms drawn, and suppose the potentiometer reading to be 30. Then the resistance of the large current coils is ·077 ohms, and the electromotive force on it is $1{\cdot}435 \times 100/30 = 4{\cdot}78$ volts, so the current was $4{\cdot}78/{\cdot}077 = 62{\cdot}07$ ampères. The resistance measured is, of course, really that of the large current resistance and potentiometer in parallel. Instead of one potentiometer wire two or three may be used in parallel, contact being made on one after the other. If the position of no deflection is the same on all, it may be assumed that the potentiometers are correct.

FIG. 31.

If secondary cells are not at hand a dynamo may be used as a makeshift. In that case the large resistance should be made with as little self-induction as possible, and the dynamo should have its commutator in good order, and should have a large number of sections. The current used for measuring the resistance should, of course, be small.

So far it has been assumed that the calibration is done from standard cells. Many prefer to use voltameter methods. In this case a standard instrument is calibrated by deposition, and the instruments sent out are calibrated from it, as it would be too tedious to calibrate commercial instruments throughout their scales by deposition methods.

Silver and copper voltameters are always used. Of these, the silver voltameter is used when very accurate results are desired, but for most practical work the copper voltameter is preferable. The silver voltameter needs more care to make it give results of the highest accuracy, while the copper voltameter, which does not under any circumstances give such accurate results, is sufficiently correct for commercial work without demanding such special care in use.

The different kinds of standard cells recommended by different authorities have been numberless, but the Clark cell is now generally considered the most accurate, and it has been assumed in these articles that that standard is used. Standard Clark cells can be bought for about 30s. from Messrs. Elliott or Latimer Clark, Muirhead & Co. Many prefer to make up their own standards.

The standard Clark cell consists of mercury in contact with mercurous sulphate, and zinc in contact with zinc sulphate. The mercury should be pure. Messrs. Becker & Co. keep an apparatus for re-distilling in vacuo, so the mercury can be got from them. Pure mercurous sulphate and pure zinc sulphate and pure zinc can be bought from any of the well-known chemists. The mercurous sulphate is boiled several times in distilled water to wash it. Messrs. Wright and Thompson pour the mercury hot and recently distilled into the cell, and then pour in a hot thin paste of mercurous sulphate and saturated hot solution of zinc sulphate. The zinc sulphate crystallises on cooling, and makes the paste partly solid. When the mercurous sulphate has settled the extra solution is drawn off by a pipette. The zinc rods are brightened by glass paper, and are washed with ether, alcohol, and the zinc sulphate solution successively before immersion in the paste. A copper wire is soldered to the zinc rod, the joint being coated with gutta-percha. The zinc rod is held in position by a slice of cork boiled in paraffin. Messrs Wright and Thompson make connection with the mercury by using a U-tube as the cell, one leg being quite small so as to admit a platinum wire only. An ordinary German glass test tube will do, and the mercury connection can be made by leading a small platinum wire through a small glass tube sealed over it, so that only a short piece touches the mercury, the end of the glass passing below the surface of the mercury. The electromotive force of the cell is 1·435 legal volts at 15°, according to Lord Rayleigh. The electromotive force falls as the temperature increases. Messrs. Wright and Thompson give 0·041 per cent. per degree C. as the coefficient. Lord Rayleigh and Helmholtz have given a higher figure, ·082, and Pellat, by inserting a thermometer in the cell itself, finds ·0781 per cent., so that ·08 is probably about right.

Standard cells should not be used for a week or so after being made up. Dr. Muirhead has brought out a standard cell in which there is no mass of mercury, so that it can be sent about without damage. He uses an amalgamated platinum wire. The wire is curled up into a flat spiral, heated red hot, and plunged into mercury, which then amalgamates it superficially. Dr. Muirhead makes up a pair of cells with an enclosed thermometer, with its stem bent over the top of the case so as to read horizontally. These cells can be obtained from Messrs. Muirhead & Co., of Cowley Street, Westminster.

Any number of different forms of standard Daniell cell have been proposed, and this is a strong argument against the use of any of them. The best form is probably that of Prof. Fleming. This consists of a U-tube with means of drawing off the solutions at the point where they meet, so as to prevent error from diffusion. This cell has been frequently described in electrical papers. The chief advantage is the small temperature error; and the cell is probably less influenced by giving a small current. Lord Rayleigh has tried short-circuiting Clark's cells through various resistances, but nothing is said about passing currents backwards. A cell accidentally short-circuited through even 1,000 ohms for several minutes recovers practically in quarter of an hour.

Little has been said about calibrating ammeters by deposition, because the methods by resistance and standard cells seem more reliable. In the hands of very careful experimenters silver or copper voltameters may be used.

For copper deposition Mr. Gray, who has gone into the matter very thoroughly, finds the cathode or gain plate should be of such a size that it has about 20 square centimetres to the ampère, or a somewhat greater surface. The cathodes or gain plates may be made of thin copper. The edges should be rounded off and the surface cleaned and polished with silver sand, then well

washed and dried on blotting paper and warmed. They are then ready for weighing. They must be allowed to cool first, of course, otherwise a large error would be introduced. Care must be taken not to touch the cleaned plates with the finger, as it is always to some extent greasy, and the deposit would be had showing a finger mark. The plates, both anode and cathode, should be made of pure copper. What is sold as pure copper is generally electro-deposited. Electro-deposited copper may be pure, but it seems rather a bold assumption. It is generally supposed that a metal must be pure because it has been electro-deposited, but there is no reason why this should be taken as certain.

The solution should be made of a density of about 1·1 to 1·2, distilled water and pure copper sulphate being used. The solution should be slightly acidified with sulphuric acid. Mr. Gray finds ·000329 gram per coulomb the constant when the gain plates have an area of 50 square centimetres per ampère. It is best then to adhere to this current density. This is equal to 1·1844 gram per "ampère hour." For further information relative to copper deposition the reader is referred to Mr. Gray's paper in the *Philosophical Magazine* for November, 1886. An abstract of his British Association paper in the same year appeared in these columns.

For silver voltameters, Lord Rayleigh prefers to deposit the silver on the inside of a platinum bowl. Mr. Gray, on the other hand, prefers plates. The great difficulty in silver deposits is the washing and management of the gain plates. The deposits are apt to be very loose, and little crystals tumble off if the greatest care is not taken.

The silver plates should be cleaned in the same way as the copper gain plates. The solution used should be about 5 or 10 per cent., that is 1 ounce to 2 ounces of silver nitrate to the pint of distilled water. Lord Rayleigh prefers a 15 per cent. solution. The plates should have an area of from 200 to 600 square centimetres per ampère. Still greater care is necessary in cleaning the gain plates, as the least thing will make the deposit loose. Distilled water must, of course, be used for washing the plates. Hard water would deposit silver and calcium compounds among the crystals of the coating. Lord Rayleigh gives ·001118 as the silver deposited by a coulomb, or 4·0248 grams per ampere hour.

The great trouble in calibrating by deposition is that only small currents can be measured. The writer has begun a series of experiments in which mercury is used, currents giving about 100 times the current densities mentioned being used. These are not yet ready for publication, though the method shows promise, and will, it is hoped, admit of the direct checking of large current ammeters.

(*To be continued.*)

REVIEW.

Technical School and College Building : being a Treatise on the Design and Construction of Applied Science and Art Buildings, and their Suitable Fittings and Sanitation, with a chapter on Technical Education. By EDWARD COOKWORTHY ROBINS, F.S.A., F.R.I.B.A., &c., &c. London : Whittaker & Co.

FIFTY years ago, when foreign countries began to construct railways and to fit up mills and mechanical workshops, our industrial organisation was so thoroughly established, that not only was this country alone in its advanced development of practical and mechanical industries, but to a foreigner, who was unacquainted with the internal working of our factories, the whole system was as a closed page. England, in consequence, was without a rival, and people abroad were compelled to supply their wants at her mart, and to labour under the necessity of employing her engineers and mechanics or skilled workmen to lay out railways and other works of construction, to erect and superintend the machinery exported from her shops, and to instruct the untrained foreign hands in its application. So unskilled were some of the local workmen, that there is a case recorded of an English engineer on a Spanish railway finding it absolutely requisite to cut templates of each separate piece of wood forming such a simple example of carpentery as a wooden gutter. It is not surprising, therefore, that in those days trade was brisk, work plentiful, and wages of competent artisans at a high rate. Under the English system of long apprenticeships the manual dexterity of the workman was assured, and the work that he turned out would be of a high class and calculated to sustain and possibly to enhance the reputation of his employers for issuing manufactured goods of superior quality, combined with the certainty that the standard of excellence would be kept up to the satisfaction of the consumer.

Not long in perceiving their backwardness in industrial arts, the Continental nations prepared to meet this state of things by instituting technical schools like the Ecole Centrale of Paris and the Polytechnic Schools of Germany and Switzerland, and sending engineers and other scientific men to England to study the subject and fit themselves for the posts of professors in these new schools. Acknowledging the English system in the matter of practical work to be ahead of anything then in existence, they took it as the basis of their technical teaching, supplementing it with scientific instruction in these schools, which have since become the recognised training field for students who desire to take their position as directors or managers of industrial establishments. With very few exceptions these schools and laboratories have been erected and are supported by the State, vast sums having been expended in their construction and fittings. On their professorial staff may be found some of the most world-renowned scientists, as for example, Profs. Helmholtz, Zeuner, and others equally distinguished in their own particular branch of abstract science. The fees charged to the student for such unequalled chances of study are fixed at a low scale ; at the same time, the professors are so numerous that the teaching partakes of a private character amid the wider sphere of a public college.

One incentive a German boy has to personal educational improvement while at secondary schools, and which will always be absent in this country, lies in the knowledge that when he passes certain examinations he will be relieved from two out of the three years' compulsory service with the military forces.

Not content with providing the Universities and the Polytechnicums with every appliance and inducement to further scientific education ; the system of acquiring theoretical knowledge to fit candidates for the situations they are to occupy in their future life, is also carried into commercial education ; and so rigorous is the training that at some mercantile centres the sons of the most opulent merchants or bankers are not exempted from the general rule. The boy, after passing through the usual secondary school, has to be articled to some merchant to learn the practical duties attaching to a business career. Here he remains three years, first as an office boy and afterwards as a junior clerk, and, at the end of his time, he receives an honorarium according to his deserts ; this curriculum reduces his military service to one year, and on the completion of this he can dispose of his talents as he himself thinks best. It may be owing to this training that so many German clerks are finding employment in London, putting on one side the additional recommendation of having an extra modern language at their command. The Paris Chamber of Commerce, following the German example, has erected an "Ecole des Hautes Etudes Commerciales" at an expense of some £80,000, to show the value the Chamber places on a sound theoretical foundation for mercantile pursuits.

For the working classes in Germany and Switzerland schools are in existence intended to give a technical and half scientific, but still a practical education to workmen, so as to fit them for foremen's places, and we understand that these schools have met with great

success. Apprenticeship schools were established in France, and large amounts have been spent to extend their usefulness, and judging from the report of the Prefect of the Seine that apprenticeships in most trades was virtually abolished, it is more than ever necessary that the workman should bring an intelligent mind to bear on his daily work. All these endeavours to elevate the standard of technical teaching have not been confined to countries like France or Germany, but equal exertions have been made in Russia, Sweden, and Italy, and it follows that a great practical advance has taken place in the output of manufactures and in the mercantile enterprise in distributing them over the surface of our globe.

This country has been the sufferer in several ways; firstly, by the gradual exclusion of our goods from foreign countries by prohibitive duties; secondly, by the advantages derived from the successful theoretical training in force abroad, totally unopposed by us until quite reeently; and, thirdly, in the words of Sir Frederick Bramwell, that "The markets of this country were open to the whole world, and our colonies were indifferent as to whether produce came from the mother country or foreign countries; so the English manufacturers and traders had to meet at home and in the colonies the manufacturers and traders of the whole world unaided by any protection. Whatever his determination, the Englishman was badly handicapped in his struggle with his foreign competitor, if the latter had the means of applying science to his industry when the former had not.

Technical education has thus forced itself into the notice of our countrymen and placed itself in the foremost rank among the important questions of the day; this public attention has called forth the fact that, although our system of elementary and ordinary secondary tuition may be as good as that of other countries (with the exception perhaps that drawing takes a more important place in foreign schools), our means for placing a scientific and technical course within reach of the middle classes at a moderate cost were hopelessly left in the rear, by the magnificent schools and laboratories provided by foreign nations for the education of their future professional men. Government initiation being out of the question in England, it was left either to the patriotic enterprise of private individuals like the late Sir Josiah Mason, of Birmingham, or the brothers Platt, of Oldham, who respectively founded Mason's College and the Oldham School of Art and Science, or to those representatives of the various trade corporations of the middle ages who, with traditions descending from generation to generation without interruption, and with all the experience derived from the lessons and knowledge acquired during a period of some 500 years, are embodied under such titles as "The City and Guilds Institute of London" or the "Merchant Venturers of Bristol." These ancient corporations, of which the above are notable examples, ever ready to step forward in defence of public rights, ever ready to assist any cause which in their judgment is deserving of being supported—and their accumulated records during past ages would undisputably give them a pre-eminence over the ordinary world of men in forming a just opinion—and ever believing in the utmost extension of granting facilities for instructing their citizens, have come to the aid of their countrymen, lavishly expending heavy sums of money in founding such noble institutions for technical education as the Central Institution at South Kensington, the Technical College, Finsbury, schools of art, &c., in various parts of London, as well as erecting such a beautiful building as the Merchant Venturers School and Laboratories, Bristol.

The companies individually have not been behind hand in the good cause, many special trades having to thank them for erecting schools and laboratories of instruction in the manufacturing centre of the particular manufacture, and the universities are following in the wake of the corporations by constructing physical laboratories.

The work on Technical School and College Buildings, by Mr. E. C. Robins, which has given rise to the above remarks, commences with a chapter on English and Foreign Technical Education and an analysis of the second report of the Royal Commissioners on Technical Education; the remainder of the book is devoted to descriptions of the most important buildings in various countries illustrated fully by more than 60 page or two-page plans and elevations including details of lecture room fittings, chemical working tables, &c., down even to the design of the black board in use at Finsbury College. Chapters on heating and ventilating and Griffith's system of sanitary drainage are added with accompanying plans, rendering the treatise comprehensive and up to date, though it may here be noted that in warming class rooms it is requisite to allow a larger surface in the heating apparatus for the rooms occupied by girls, than in those constructed for the use of boys. The only omission we regret discovering is, that having read a statement by Mr. Mather to the effect that the Boston School of Technology, Massachusetts, U.S.A., was considered by him to be the best technical school in the world, no plans or detail drawings are given. We are entirely of one mind with our author in his predilection for the "Hall Passage System" used in his own designs; by this plan the great hall is made "the centre of civilisation" to the school, every door opening into it, thereby doing away with the use of dark, close and dreary passages.

There is the more hope in expecting important results from the institution of so many schools scattered over England, seeing that the much-abused South Kensington School of Art has been the means of so much real progress in improving the artistic productions in this country, and that the Austrians have professedly based their new Industrial Art School and Museum on the lines of South Kensington, and we trust that having made so fair a start towards placing a sound technical and scientific education within reach of every class of the people our countrymen not fall back under the spell of habitual apathy and contented submission to things as they commonly are.

PROPOSED ELECTRIC LIGHTING AT BATH.

AT a recent meeting of the inhabitants of the City of Bath a resolution was passed favouring the adoption of the electric light for public lighting purposes, and this having been forwarded to the Town Clerk formed the basis of a discussion at the last meeting of the Corporation.

The MAYOR pointed out that such a proposal as the introduction of electric lighting into the city would require very serious consideration indeed. He had himself been very much struck with the beauty and harmlessness of the electric light as displayed at certain public buildings in London.

Mr. STURGES then moved that the question of adopting the electric light for the streets of the city should be referred to the Surveying Committee to enquire and report to the council. No one, he submitted, could object to such a resolution as that, because he did not ask them to pledge themselves to the expenditure of a single halfpenny, but merely to allow the facts of the case to be fully and fairly placed before them. Over a thousand citizens attended the meeting at the theatre, and they were all unanimously in favour of the electric light, which under the supervision of Mr. Massingham had proved so successful during the Jubilee celebration at Bath, and was giving general satisfaction at Taunton, where it had been permanently adopted.

Mr. COX and Alderman GIBBS thought that the matter should be referred to a special committee, the latter remarking that he thought they might congratulate themselves that they did not take the question up some years ago when it was introduced by Mr. Sturges, because the position of those desiring to effect the change was now considerably strengthened by the experience gained in other places.

Alderman CLARK held that a special committee was not necessary, as there was no doubt of the efficiency of the electric light, and the only question was whether it could be produced at a cost within reasonable limits. It would have to be adopted at some time or other, and there was no reason why the Bath Gas Company should not undertake the task.

Eventually it was decided to appoint a select committee to investigate the matter.

NOTES.

Electric Lighting in Continental Theatres.—The manager of the theatre La Renaissance, at Paris, has just signed with M. Clémançon a six years agreement for the electric lighting of his establishment. The installation is to be complete for the re-opening of the theatre.

M. Clémançon is also in treaty for the electric lightihg of the theatre l'Ambigu.

The Continental Edison Company has undertaken the installation of the electric light in the theatre des Menus-plaisirs at Paris.

French Gas Engineers and the Electric Light.—The more enlightened amongst French gas engineers are taking great interest in electric lighting, and a paper by M. Delahaye on the cost for isolated installations, read at the annual congress at Nancy received appreciative attention. The author took as a sample plant one of 200 16 C.P. lamps, and estimated its first cost as £1,120, inclusive of motive power. The plant contains a 25 H.P. steam engine and boiler and a dynamo machine, but no accumulators; and with coal at 20s. per ton, and an average of six hours per day for each lamp, the author arrives at the somewhat low estimate of ·35d. per lamp hour. This figure will probably be considered too low by English readers, and curiously enough the author, when treating of central station lighting, comes to the conclusion that it could not well be done under ·6d. per lamp hour. This figure is also borne out in practice by the fact that one of the central stations lately established in Paris charged their customers at the rate of 1d. per hour for each 16 C.P. lamp.

Electric Lighting in Roumania.—The centre of Barmen is to be lighted by 5,000 glow lamps, which will be supplied with current from a central station. The cost is estimated to be "something under £20,000."

Electric Lighting in New Zealand.—The directors of the Timaru Milling Company celebrated the inauguration of the electric light in their mills on June 21st by giving a champagne supper to a number of gentlemen who were desirous of witnessing the new illuminant in operation. Great satisfaction was expressed with the lighting, and the health of Mr. Walter Prince, who carried out the installation, was cordially drunk.

Patent Claims.—One of the claims in the specification of H. J. Harris, No. 8,228, July 7th, 1885, runs thus:—"In a closed voltaic battery, providing an outlet for the escape of gas from the porous cells only, substantially as herein described." Is it possible that the inventor of the "Eclipse" battery has never seen a Leclanché pile?

Conductors for Electric Tramlines.—So far as one is capable of judging from the results of actual experience, it looks as if underground conductor systems are not so easily managed and kept in order as those which are put a little above ground or overhead. Accidents, fatal to quadrupeds, have happened, both in the United Kingdom and in America from the last-mentioned systems, but such occurrences can with ordinary care be avoided, while the cost of maintenance must be considerably less, taking the Blackpool line as an example of the buried conductor method.

The "Eclipse" Battery.—Intending purchasers of stock in the Eclipse Electric Battery Company have now the extra inducement of knowing that "since the prospectus was issued the Belgian patent has been granted." However, the public will not be caught napping by such a bait as this.

The Institution of Mechanical Engineers.—Mr. Geipel's paper, to which we drew attention in one of our recent issues, has been postponed till the January meeting of the Institute in London.

Incandescent Lamp Patents.—We have received, just as we are going to press, a long letter from Mr. Shippey respecting our comments on the recent law suit in which he figured. We have no choice but to hold it over for our next issue.

Gas in Theatres.—Gas continues its exploits in theatres. Recently, during a concert given in the Nimes Theatre, on the occasion of the distribution of the prizes to the pupils of the Conservatoire, there occurred an explosion of gas in one of the boxes. A fireman was seriously wounded. The authorities hastened to the scene to calm the panic which had spread among the pupils. As for the spectators, they kept quiet, ignoring the risk they had run; had they done otherwise, numerous accidents would have had to be deplored.

A more serious calamity occurred at the concert of the Pré-Catelan at Toulouse. A fire broke out at 2 a.m., and in spite of immediate assistance the scene, the performers' rooms, the furniture, chairs, and couches were destroyed. The loss is estimated at 60,000 francs. The fire was due to an escape of gas, after the performance.

The Eclipse Battery Company.—We learn from Thursday's papers that an offer has been made for the purchase of a portion of the foreign patents relating to the Eclipse Battery, which will enable the company to pay a dividend of 100 per cent. on the contract being signed. But the contract has not yet been signed, and we do not think the shareholders in the company will ever get the half of 100 per cent. on their investments. Our opinions of the concern may be found in our leading columns. The subscription lists, we learn, will be closed at noon on Monday next both for London and the country.

Electric Railways.—At the last plenary meeting of the Municipal Council of Buda-Pesth, *Industries* reports, two important resolutions were carried, both affecting the construction of electric railways in that town. About a year ago a project for an electric railway along the Danube quay through the town was submitted to the authorities, and the latter received the scheme favourably, the Minister of Commerce promising to give the concession provided that the contractors (Messrs. Siemens and Halske, of Vienna) could come to terms with the town authorities regarding the method of construction, rent of land, payment of rates, &c. The terms now adopted are the following:—The railway will be above ground and follow the quay, the town will not make any charge for the land required for the line, but the land required for the generating station will be let at its ratable value, which is considerably lower than its actual value. In return for these facilities, the contractors will be required to hand over to the town a certain portion of their earnings, provided the latter exceed 6 per cent. of the capital outlay, and the compulsory acquisition of the railway by the town shall not take place at an earlier period than 40 years after the date of the concession. The second resolution referred to a small experimental railway about 450 yards long, which is to be laid along the Ringstrasse from the railway station of the State railways to the Königsgasse. This line will also be built by Messrs. Siemens and Halske, and must be completed before October 1st, in order to be available at the time when the members of the Hygienic Congress, which will assemble in Vienna this autumn, will visit the Hungarian capital. The system will be that of an underground conductor laid in troughs under the rails. The line is only an experimental one, having for its object to generally demonstrate the convenience of this system of urban traffic, and the contractors undertake to remove the line should the Municipal Council require it. In this case the removal must take place and the road be made good again within three months of receiving notice.

"Newspaper Nonsense."—Since our leader upon the subject of the "Eclipse" Battery has been in type we have received the following communication from Prof. Silvanus Thompson (too late for its insertion in our correspondence columns):—"I should hardly have thought that it would have been expected of me to notice the journalistic nonsense that unfortunately appears from time to time in the daily press, and which you rightly characterise as balderdash. It is difficult to me to understand that your editorial pen should have written the phrase on page 146 of your last issue, which assumes that I have any 'connection' therewith. This sort of stuff has been very rife of late in relation to a certain battery to which your correspondent refers, and about which he interrogates me. I have seen a form of electric safety lamp worked (as I was informed) by the battery in question; and, interested as I am, and hope long to be, in the safety-lamp question, I have spoken publicly, without fear, fee, or favour, upon such merits as it seemed to me to possess. I intend to do so again at a not-distant date. But you really must not make me responsible for the journalistic vagaries which construe a speech upon a safety-lamp into a report upon a battery; which represents me as saying that I am 'amazed,' when I said I was 'amused' at certain details of construction; which stretch thirteen hours into twenty-five; and which put into my mouth sundry other utterances that are, to say the least, fictitious."

[How Professor Silvanus Thompson can send us the above letter in the face of the fact that the annexed epistle of his has been issued with the prospectus of the company (a copy of which was forwarded to us) we cannot imagine. He has undoubtedly, by maintaining until now silence on the subject since the prospectus was issued, allowed improper use of his remarks to be made, which may have had the effect of unduly influencing the public to subscribe for the shares of this company. This treatment of the matter we cannot too strongly condemn; a moral responsibility rested, we think, with the Professor to see that no such use of his name and reputation should be made. His letters when viewed side by side speak for themselves. We wish he had spoken more cautiously, if not *fearfully*, and had given people, who do not know him as well as we do, no opportunity for suspecting fee or favour. As regards the company, and seeing that Prof. Thompson now qualifies his published remarks with reference to this matter, we shall be surprised if some who may have applied for shares do not now demand to withdraw their applications before the directors proceed to allotment, an allotment which under the circumstances we hold will not be justified even if it be possible.—EDS. ELEC. REV.]

[COPY OF LETTER.]

City and Guilds of London Institute.
Technical College, Finsbury, London, E.C.
March 23rd, 1887.

Dear Mr. Walsh,—Now that I have had the opportunity of trying your "Eclipse" battery in my own library, I am able to confirm in general terms what you told me that the battery would do. At the thirteenth hour it had not flagged in the least, and was good for some time longer. I am pleased, if not amused, at the extreme simplicity of the arrangement for connecting the zincs, which has got over the miserable trouble of clamps, solderings, and binding screws. I hope you will make a good thing out of your battery; there is certainly money in it.

Yours faithfully,
(Signed) SILVANUS P. THOMPSON.

J. J. Walsh, Esq., The White House, Telegraph Street, E.C.

A Combined Telephone and Telegraph.—Col. Renard and M. Northomb have invented a system of combined telephony and telegraphy, experiments with which have just been made at Brussels. The apparatus is contained in a leather case, and connection can, it is said, be made with any existing telegraph line. The inventors state that they can speak and signal with perfect ease through a bare wire laid on the ground if the distance does not exceed two miles. The system is supposed to be particularly adaptable to the purposes of easy communication between the advance guard of an army and the main body in times of warfare.

Private Telephones in Germany.—It has been decided that the German Post Office has a monopoly only for transmitting news and messages in the public service, and that it can exercise no control over private lines, telegraph or telephone. A manufacturer at Ratibor, in Upper Silesia, some years ago, in ignorance of the law upon the point, agreed to pay the Post Office an annual tax of £3 15s. for permission to use a private telephone line which he had erected between his office and his works. He lately discovered that he is under no legal obligation to the Post Office and declined to continue paying the tax. A law suit followed, but the decision was in his favour.

Popularising the Telephone.—The Western Counties and South Wales Telephone Company has adopted a scheme which is likely to still further popularise its exchanges. The arrangement in question is that if ten or more persons living in a particular district, say within 300 yards of a centre, decide to join, the rental will be £5 each per annum; if less than ten, but more than five, the rate will be £6.

The Telephone Service in London.—About sixty members of the Home and Foreign Produce Exchange, Limited, Hibernia Chambers, S.E., have signed a petition to the directors of the United Telephone Company, Limited, requesting them to improve the communication between the Middlesex and Surrey sides of the water.

Platinoid.—It is well that the London Electric Wire Company should come forward in the interests of the recently discovered alloy, platinoid. Surely the exhaustive tests made by Sir William Thomson and Mr. Bottomley carry greater weight than mere off-hand statements such as those so frequently made at meetings of American electricians; yet Mr. Swinburne seems to have allowed himself to be influenced by Mr. Weston's useless experiments.

Electric Cars on Street Tramways.—At the sitting of the Select Committee of the House of Lords appointed to inquire into the West Metropolitan Tramways Provisional Order, on Thursday, Mr. Clifford, who appeared for the company, said that they did not propose to use electric or other mechanical power except with the consent of the Board of Trade, and then the experiment was only to be tried for seven years. The Bill was opposed by the Metropolitan Board of Works, who wanted powers introduced into the Order to enable them to stop the use of the new power.

Telegraph Clerks.—In answer to a question from Mr. M'Cartan last Friday, Mr. Raikes said that under the Fawcett scheme the second class of telegraph clerks at the Central Telegraph Office received equal benefit with the class above it. The scales of the superintendents and the assistant superintendents had not been raised on two occasions since 1881, and no further increase of scale was in contemplation over that given this year. The clerks highest on the second class had not longer service than those last promoted to the first class had at the time of their promotion. The class of senior clerks was now full. The practice in London was somewhat different from that in Dublin, and it was not intended to fill all the places on the first class at once.

Practical Electrical Formulæ.—We have received from M. Hospitalier a copy of a circular which he is issuing to the correspondents of *L'Electricien* and others, with the object of improving the sixth edition, 1888, of his "Formulaire pratique de l'Electricien." Inventors and manufacturers are requested to send in, before September 15th, 1887, technical information relating to the latest forms of dynamos, motors, batteries, accumulators, transformers, lamps, measuring apparatus, &c., &c.

Electric Lighting in Paris.—The Municipal Council of Paris has concluded its session without having examined the applications for concessions for electric lighting deposited at its office some months back.

Atlantic Cable Rates.—It is announced that the Commercial Cable Company will reduce its rate unless the other companies advance theirs within a fortnight; Anglo-American shares better on the market in consequence.

Insulators in the House of Commons.—It may interest our readers to know that the new insulator referred to by the Postmaster-General in the House of Commons is that of Mr. Slater Lewis, the managing director of the Telegraph Manufacturing Company, Helsby. The experiments made on the lines of the Postal Telegraphs with the new insulator have been in hand for some years past, but a final test is now being made with 10,000.

Measures for Safety in Theatres.—The Municipal Council of Paris has adopted the following "project of deliberation":—"There shall be added to the Superior Commission of Theatres, instituted by the decree of 1881, five municipal councillors, elected by the council; a manager or ex-manager of a theatre, a head mechanician and an electric engineer. A maximum delay of three months, dating from the first notification, will be granted to all theatres and concert halls for substituting the electric light for gas on the stage, in the auditorium, and in all other parts of the theatre."

Novel Switch-Board.—Messrs. Sudworth & Falkenstein have just completed to the order of Mr. C. P. Elieson a switch-board of novel construction for the electric launch, *The Countess*. The main accumulator switch controls six sets of 65 accumulators, and is so arranged as to put them, all in parallel, three in parallel and two in series, and two in parallel and three in series, as required. To effect this the six positive terminals are connected to six brush contacts ranged vertically on a slate support, the six negative being similarly connected to another set of contacts on a slate opposite. To connect the brushes and complete the accumulator circuits, a casting consisting of three pairs of arms is placed so as to revolve between the slate supports by turning the handles. Insulated gun-metal contacts are fixed on the arms, and make contact with the brushes, which are of copper; one pair has a single contact piece on each arm which joins all the positive and negative brushes, thus putting all the sets in parallel. The second pair of arms has two contact pieces on each arm, and puts the sets three in parallel and two in series. The third pair has three contact pieces on each arm, and puts the sets two in parallel and three in series. In the last two cases cross-connections of copper strips connect opposite contact pieces. Sufficient elasticity is given to the brush contacts by mounting the brass supporting arms, on india-rubber washers placed between the slate support and the horizontal extension of the brush-holder. The brushes are held in their respective holders by set-screws and can be adjusted for wear by being taken out and faced up if necessary. The main dynamo switch being off before any change is made in the accumulator switch prevents any wear through sparking. The rest of the switch board consists of a two-way main switch for charging and discharging, and the necessary cut-outs and terminals, the former being mounted on vulcanite bases, the board itself being of enamelled slate. The board has been constructed and all connections made under the direction of Mr. W. Peto.

Errata.—In line 4 of the second paragraph on page 135, last week, ("Recent Advances and Improvements in the Application of Electricity to Railway Working"), read, "should the *section* be clear," and not "station." In lines 2, 3 of the next paragraph read "and a similar arrangement *of* apparatus" instead of 'or."

Accident with the Electric Car System.—At Montgomery, Ala., Governor Slay and his private secretary, Mr. J. K. Jackson, have just narrowly escaped serious injury, if not death, from the electric current. They were driving down the main thoroughfare of the city when one of the guy wires supporting the overhead cable of the electric street railway broke and fell to the ground, striking the Governor's horse, which received a severe shock, and, according to the newspaper account, "was burned to death in a few minutes."

Volk's Electric Railway.—In answer to Mr. Picton in the House of Commons last week, the Chancellor of the Exchequer said Volk's electric railway was not assessed to railway passenger duty, the ground of exemption being that it runs upon a public way and not on private property. Carriage licence duty, however, was paid in respect of the cars used by the company.

Festivities.—The annual dinner to the *employés* of the Electrical Power Storage Company took place in the banqueting hall of the Royal Pavilion, Brighton, on July 30th. The dinner was served promptly at 12.30, the chair being taken by Mr. J. Irving Courtenay, managing director, and the vice-chair by Mr. E. Clark, foreman of the works, in the unavoidable absence of Mr. W. H. Patchell, works manager. The chairman proposed the loyal toasts, and the vice-chairman "The Company and Directors." After these toasts had been duly honoured, the chairman described the extensive application at home and abroad of the E.P.S. accumulators, and especially the rapid growth of the demand for them in America within the last 18 months. After several songs and speeches the company dispersed for the beach, and met again at 8.40 at the railway station, where the special carriages provided by the London, Brighton and South Coast Railway were waiting for the return journey to London. This was the fifth annual dinner of the E.P.S. *employés*.

The Production of Aluminium.—The company that was started a few weeks ago for the purpose of carrying on the manufacture of sodium and aluminium under Castner's patents is now getting out plans for the erection of works for that purpose. Mr. Castner himself is to be the general manager of the concern, and Sir Henry Roscoe, M.P., will be the consulting chemist. The company proposes to erect works in Lancashire and in the United States. It can produce aluminium profitably at 15s. to 20s. per lb. There has recently been a rumour afloat that some new process has been discovered whereby aluminium could be made at an even cheaper rate than this, but such a statement is hardly likely to prove correct, *Industries* thinks. The production of aluminium by the electric current does not so far seem to be a formidable rival.

The "Eclipse" Battery. — The subjoined letter, which we are informed is a copy of one which has been sent to the daily papers and not inserted, reached us too late for publication in our Correspondence columns:—"A prospectus of the 'Eclipse Electric Battery Company, Limited,' was addressed to me, and being much impressed by the achievements claimed for this battery, I was on the point of applying for shares, when last week's issue of the ELECTRICAL REVIEW came to my hands. The various statements contained in this paper about the inventor, and the reflections cast upon the invention are of such a damaging nature that I consider I have acted not more than judiciously in postponing my application until the directors have proved the want of foundation for these serious allegations. If the directors ask the public to subscribe £70,000 for the acquisition of the patent rights it seems to me that these should be unquestionably valid, and that the invention should be able to do all that is claimed for it. Now I understand from this technical paper that not alone are the patents not such as they are represented, but also that independent experiments do not bear out the statements as to the durability, &c., of the battery.—PERPLEXED."

Elieson's Electric Locomotives.—With reference to the remarks in our last week's issue concerning the breaking of the armature wires, we farther learn that the locomotives were delivered by the contractors and in the hands of the Electric Locomotive Company for eight months previously to the break down. During that time countless experimental journeys were made under the most crucial conditions, and no weakness in construction was manifested. This renders these breakages all the more mysterious.

Fires in London.—From a return presented to the Metropolitan Board of Works, it appears that in the forty-eight hours between 6 a.m. on Saturday, the 6th, and 6 a.m. on Monday, the 8th of August, notice was received at the head-quarters of the Fire Brigade of fifty-one fires.

Electric Fire Alarms.—Messrs. Cox-Walker & Co., of Darlington, have just completed the fitting up of the Somerset and Bath Lunatic Asylum at Wells with their system of electric fire alarms, which had previously been adopted for the county asylums at Lancaster and elsewhere. The working of the firm's electric "silver medal" tell-tale at Dorchester Asylum is pronounced by the medical superintendent to be "as near perfection as possible."

Electricity in New Zealand.—Mr. Walter Prince, of Dunedin, is under contract with the United Alpine Gold Mining Company to carry out the electrical transmission to a distance of a mile and a half of 10 horse-power to work an air-compresser employed for boring purposes. The plant reached Dunedin in June, and on the 23rd of that month was tested in the presence of a number of gentlemen interested in engineering and mining. The test was satisfactory, and success to the undertaking was drunk in bumpers of champagne.

A Russian Lighting Exhibition.—Russia has at length caught the craze for exhibitions, and one devoted to lighting materials and mineral oils will be opened in St. Petersburg, under the organisation of the Imperial Russian Technical Society, in the month of November, and will last three months. Electricity, of course, forms one of the departments. Exhibits will be received from August 27th to October 27th. Application should be made before the first-named date to the Committee of the Exhibition, Russian Imperial Technical Society, St. Petersburg, Panteleimonovskaja, No. 2.

City and Guilds of London Institute.—The report on the technological examinations for 1887, held in May and June last, has just been issued. The increase in the total number of candidates examined and of those who have passed is satisfactory. In 1886, 4,764 candidates were examined, of whom 2,627 passed; in 1887, 5,508 were examined, of whom 3,090 passed. The increase in the number of candidates in 1887 is 744 as against 796 in 1886. Examinations were held this year in 48 subjects. In 30 of these subjects a larger number of candidates presented themselves than in 1886, the increase being chiefly in the textile and engineering trades, in carriage building and in plumber's work. In telegraphy there were 110 candidates, of whom 14 passed first in honours and 7 second, 3 failing; 36 gained firsts in the ordinary class, there were 20 seconds and 30 failures. The number of passes was thus 77, the percentage of failures being 30·0. In electric lighting the figures were:—Candidates, 184. Honours: first, 17; second, 16; failed, 13. Ordinary; first, 45; second, 55; failed, 38. Total passes, 133; failures, 51; percentage of failures, 27·7. Electrical instrument making. Candidates, 9. Honours: first, 1; second, 2; failed, 1. Ordinary: first, 2; second, 3. Total passes, 8; failures, 1; percentage of failures, 11·1. Electro-metallurgy: Candidates, 25. Honours: first, 1; second, 3; failed, 5. Ordinary: first, 7; second, 3; failed, 6. Total passes, 14; failures, 11; percentage of failures, 44·0.

Telegraph Works on Fire.—An extensive fire engaged the attention of the East End firemen for several hours on Tuesday morning, at 56 and 58, West Ferry Road, Millwall, on the extensive premises of Messrs. E. Fox and Co., telegraph engineers. The Rotherhithe firemen were first called to the fire, and it was some little time before a definite call was received. It was found that a large building of three floors 270 feet by 20 feet, and used as manufactory and stores, was well alight, and steamers and hydrants were soon got to work. More than half the building, however, was eventually destroyed.

At another large fire which occurred on the evening of the same day on the premises of Messrs. Grant and Co., of 72 to 75, Turnmill Street, E.C., a number of telegraph wires were damaged.

Electric Cars and Secondary Batteries.—Another experimental trip with electric cars propelled by means of secondary batteries has been made in Philadelphia. A number of railroad men and others met on July 26th at the works of Mr. William Wharton, jun., and inspected the car, which was an old one worn out on the Fourth and Eighth Streets line. Under the seats were arranged 84 cells and underneath the forward portion of the car was swung a Sprague motor. On the front of the dasher was an arc light, and in the car four incandescent lamps were burning. The batteries, it was stated, would run the car for about four hours, and two minutes only were required to replace one set of cells for another set newly-charged. The car was arranged under the personal supervision of Mr. Reckenzaun, whom the American papers persist in calling "Professor." The route traversed contained some very heavy gradients and sharp curves, but these were encountered without difficulty. Twelve miles an hour was mentioned as the speed attainable.

Experiments were made in New York earlier in the month with Julien motors and secondary batteries. We read that the car employed (which was sent over from Brussels) was built for much better tracks than those of most American cities, and that much difficulty was found in adapting the wheels to the rough tracks and short curves. The car was successfully run, however, for three days, traversing a large number of miles each day. Mr. William Bracken, the chairman of the Julien Company, has stated that the cars will not cost more than $4 10c. a day, running 90 miles in that time, and carrying all the passengers that could be crowded into them. The average cost with horses is $7 50c.

The Khotinsky Glow Lamp.—This lamp, which is manufactured under a secret process, is gaining its full share of favour on the Continent, and has now become a formidable rival of the Edison lamp, the patent of which, it is reported, has become void in Germany, owing to the Canadian and Italian patents having fallen through. The German Navy has now, after exhaustive tests, adopted this lamp in preference to all others. It may be interesting to learn that the Khotinsky lamp is pronounced by high official experts to be entirely free from infringement on the claims in Edison's patent. This looks like a blow to monopoly. As, however, the factory at Rotterdam is only able to deliver 300 of the daily demand of 1,000 lamps, and as the cost of extending the premises is too high, and the import of the manufactures into Germany is burdened with heavy dues and freight charges, it has been resolved to establish a second lamp factory in Gelnhausen (on the Berlin and Frankfort line), for which 200,000 mks. have already been subscribed.

Tory Island and the Telegraph.—Sir E. Watkin has agreed to take charge of a Bill in the House of Commons during the present session to enable Lloyd's to connect (at their own expense) the lighthouse on Tory Island with the mainland of Ireland by submarine cables and land wires, and to establish telegraph stations.

The Brussels Electric Tramway.—No fault, *Industries* says, can be found with the regularity and efficiency of the Brussels electric tramway service, but some improvement is necessary as regards the electro-motor. This is of the Julien type, and is rather wasteful in current, especially when the car is climbing up a gradient. In consequence, the charge in the battery becomes more quickly exhausted than need be, and the life of the battery is also shortened by the occasional excess of current.

NEW COMPANY REGISTERED.

Welsbach and Williams, Limited.—Capital: £40,000 in £1 shares. Objects: To carry on business as manufacturing chemists and metallurgists, and as an electric light and power company in all branches, but chiefly to purchase an invention of Dr. Carl Auer von Welsbach for the manufacture of incandescent lights, and the business carried on in connection therewith at 25, Theresinam Gasse, Vienna, and at 6, Jeffrey's Square, St. Mary's Axe. Signatories (with one share each): *F. de Lafontaine Williams, 6, Jeffrey's Square; *J. Mactear, 2, Victoria Mansions, S.W.; *C. H. Fieling, 14, Throgmorton Street; A. Lichdenstadt and C. T. D. Crews, 35, Throgmorton Street; E. O. R. Roose, 45, Hill Street, W,; Fanny C. E. Fieling, Eltham. Carl von Welsbach and the subscribers denoted by an asterisk are the first directors. Qualification: £500 fully-paid shares. Mr. Williams is appointed managing director for 5 years at a salary of £500 per annum, and will also be entitled to 10 per cent. of the realised net annual profits, subject to the prior payment of 20 per cent. of such profits to Mr. Welsbach. The remuneration of the other directors will be £400 per annum. Registered 3rd inst. by E. S. Garsford, 4, Mitre Court, Temple. Registered office, 6, Jeffrey's Square, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-American Brush Electric Light Corporation, Limited.—The annual return of this company, made up to the 10th March, was filed on the 6th inst. The nominal capital is £400,000 in £5 shares. The shares taken up are 25,327 with £5 paid, and 23,003 with £3 paid, the total calls amounting to £195,644.

CITY NOTES, REPORTS, MEETINGS, &c.

Edison and Swan United Electric Light Company, Limited.

THE fourth ordinary general meeting of this company was held at the Cannon Street Hotel on Tuesday last, under the presidency of Mr. J. Staats Forbes.

Major S. Flood Page, the Secretary, having read the notice convening the meeting, and the report of the directors having been taken as read,

The Chairman said the essence of the report lay in the reference to the profit and loss account. The chief feature to be dwelt upon was the fact that the profit, after charging the current business of the year, and everything which could be fairly charged against it, and that somewhat more liberally than in former years upon the items of depreciation, the result showed a profit of £16,221 17s. 8d., against £24 5s. 6d. in the preceding year. It was quite true that in that year, principally owing to circumstances which he had to explain last year, the profit of the year before, £25,000, had been reduced to nil; but they had now so far come back again that £16,221 17s. 8d. remained as the profit of the year, after being liberal in the matters of depreciation and reserve. He believed that was the whole of the report, because when they came to deal with the substance of it, it assumed the position of paragraphs in the document itself. First of all, it told them that the sale of lamps and the business of the company had progressed satisfactorily; that profit had resulted, and during the year the directors had paid off the mortgage of £3,000 on the Benwell and a like amount on the Green Street property, the financial position being by that much sounder. Then the installation work had been more active during the past twelve months. The fact was, this electric light, for internal purposes at all events, was beginning to be more appreciated year by year. The great clubs had found out that gas, although appearing somewhat more economical on payment per thousand feet, was not so economical or so advantageous as the electric light, and were thus rapidly transferring themselves from gas to electricity. The Athenæum was having the light, as were also some of the new clubs. Then, banks were finding out the same thing. They had to pay large sums for light, and their large establishments of people had had to work in vitiated air; but somehow humanity was beginning to hold its own against avarice. Men who employed a large number of people were beginning to pay some regard to the health of those people. In fact, they found it paid them, and bankers and others thought it better to use electric light than gas, because the substitution conduced to good health. He referred to the lighting of the *Times* office to show that the electric light was a great boon in the compositor's rooms of newspapers offices. In this way things were going on, and the electric light was finding its way into all the great establishments by degrees, and he dared say into a great many private houses as well. Thus it seemed to him the thing had now taken root, and they were the possessors of what might be called the key of the fortress. He trusted that in the course of time they would have a large amount of capital, and that the not inconsiderable amount of anxiety and labour thrown into the business on the part of the directors and their technical officers, and the patience and forbearance displayed in so large a degree by the proprietors, might have their fitting reward. They might, he thought, take the balance of this year as an earnest that that reward was in their reach. They had not only an advance, which was substantial, in what might be called material prosperity, but they had also disposed of some doubtful points, the issue of which this time last year had not been determined. The shareholders knew the company were the possessors of patents, and he supposed a large increase of their prosperity depended upon the validity of those patents. This was the second concern in which he had been engaged in which the investments had turned largely on the possession of patents—the telephone and this business of lighting—and he had arrived at one conclusion, which was that anybody who staked his money on a patent was a fool. That was a general proposition he would be prepared to defend if it needed defence—he meant, of course, until the validity of a patent had been established. This company was fortunate in one respect, namely, that the cost of their patent, or a large portion of it, had taken the form of contingent payment to Mr. Edison. Another portion of it was a positive payment to another illustrious inventor, and the Edison people had been much wiser than the people who were persuaded by the eloquence of that other illustrious inventor. They had to fight in defence of their patent, but they had fought, and against no mean opponents. Messrs. Woodhouse and Rawson were, he supposed, the principal ones, but he thought they were backed up by other people as powerful as themselves, whose interests were very much in the direction of their interest—that was to say, people who would be very glad indeed to use the Edison and Swan lamp without paying for it. However, they had tried this question, and had succeeded as regarded the only two patents really contested. They obtained judgments in the Court of First Instance, in both cases, and these judgments were confirmed on appeal; and though he believed the time for appeal to the House of Lords had not yet expired, he thought that he was right in saying, as far as they were at present advised, there was no probability of those particular judgments being challenged in the House of Lords. The directors had taken action wherever infringements had cropped up, as the shareholders would have seen from the *Times* law reports. Respecting these infringers, he would not say anything so harsh as that they had robbed them, but they had not hesitated to make this company's lamps and to sell them. They last week won an action against a rather notorious offender, who very frankly admitted that he had been infringing. He had brought an action in return against them for slander of title, but he was compelled to admit that he had been making lamps under their patents and selling them. Practically, as men of business, they might assume that whereas this time last year the uncertainty attaching to the validity of their patents was such as to give some serious anxiety to the directors, who had to take upon themselves the onus of determining whether the cases were to be fought or not, now the position was far more assured. He was not technical, but one did acquire, by applying common sense, a capacity for putting one's mind at ease, and his mind was pretty well at ease about the validity of their patents. Those patents had several years to run, and they must make hay while the sun shone. While dealing with the public fairly and liberally, they would now have to take the full measure of benefit from their patents, and they were taking that course; at the same time they had got a fixed policy in their minds. That was, to retain as far as possible in their own hands the manufacture of their lamps, in order that they might secure profit to themselves and to the public two advantages—the greatest measure of efficiency and the greatest measure of economy. It was quite obvious that the man who had manufactured a million things could make them at a much cheaper rate than the man who manufactured only a quarter of a million. As time went on they would diminish the price of the lamps, consistent with fair profit, and

by the time the patents expired not only establish a connection as makers and vendors of the lamp, but as the firm which supplied the best and most efficient lamp. That was their policy. That really exhausted the substance of the report and accounts. He would, however, just advert to the details of the profit and loss account, as there were one or two points it was desirable he should touch on. They had derived a considerably larger income by the sales of lamps and fittings, and charges for work done. The comparative figures showed the amount to be £65,736 this year, as against £51,998 in the preceding year. That was a substantial increase of receipt—£14,000 in round numbers. Then there was an item, which he admitted was an exceptional one, to which he would call attention; he meant the royalties from Messrs. Woodhouse and Rawson. In the earlier part of the legal proceedings, Messrs. Woodhouse and Rawson were allowed by the court to go on manufacturing and selling lamps, but were under obligation to keep an account of such sales and pay royalty on them in the event of the decision against them being confirmed. When they got the decision confirmed by the Court of Appeal Messrs. Woodhouse and Rawson proceeded to pay up, and the company had got out of it £4,217 in respect of the royalties payable during that period, which was about 12 months. But this company had also got a claim—he did not know whether it was a concrete one or could be made tangible—for damages or compensation in respect of the period anterior to the proceedings, and also for the costs in each case and up to this time not paid. They did not wish to abuse their victory—which would be not only ungenerous but bad policy—and he hoped these gentlemen would see their way to make the best of what, in their case, was a bad bargain. This company would not press them as long as they seemed determined to do what was right. Another favourable feature in the profit and loss account was with respect to the stock, consisting principally of lamps and material. They carried over in June of last year £19,384; the stock carried this year was only £15,001. Of course, they were obliged in this business to have a large number of lamps in stock. Every now and then a man woke up to the fact that he wanted incandescent lamps, and determined that he must light his place with electricity in a fortnight or three weeks, taking it as a matter of course that they would be in stock. Thus, there was an opinion on the part of the public that they had only got to come to the shop to get what they wanted, and to meet this a large stock had to be kept on hand, though they would not, of course, keep more money locked up in that way than need be. Going to the other side of the accounts, which dealt with the outgoings, the shareholders would note, the chairman observed, that wages, purchases, cost of installations, &c., amounted to £37,159, as compared with £33,430 last year. Then there was a large excess of £65,700 against £51,900 for sales and charges for work done; that was to say, £14,000 worth of stuff was not sold without some additional cost. Well, then, as to the salaries of directors and all those things which excited so much attention generally, they would be glad to hear there had been some diminution there. They stood in the accounts last year at £10,853; now they were reduced to £6,917. That, however, was not all saving, because some portion of that diminution would turn upon an alteration of posts, salaries of engineers and electricians being transferred to their proper accounts, forming part of the £37,000 for wages, purchases, cost of installations, &c. This left the salaries, directors' fees, rent, office expenses, insurance and general charges, £6,900, as against £10,853, less those charges to which he had referred, which he thought amounted to about £2,000. He was reminded that the directors had waived by £1,500 fees to which they were entitled under the articles of association. He thought they had been wise to waive them, for he did not think directors ought to prosper too much when shareholders did not. No doubt some day, when they returned larger dividends, the shareholders would bear the fact in mind. It would not be a legal, but if they did not at that time think it a moral obligation to remember it, why the directors would not ask them to do so. With reference to the item for depreciation of plant, one allowed in respect of dead matter a great deal more readily what was going on, than in respect of one's living self—namely, that it wore out. The directors found their machinery was getting older, and they thought it wise to increase the amount of depreciation chargeable on the going concern. The sum of £3,281 had been written down out of profit to meet this wearing out. It was like a man insuring his life for the benefit of his wife and children; he paid it out of pocket because he knew he was wearing down. Then the charge in respect of Holborn Viaduct, rent, restoration, &c., and Benwell, loss on removal, which stood at £3,000, was also paid out of the profit in the same way. It meant early losses being written down, or part of their original sin being wiped out. These were losses incurred by bad bargains in former times. When the directors came to put these bad things together they determined to get rid of them as soon as possible, and were now accordingly writing them off. With regard to the interest on mortgages, amounting to £883, the mortgages were now paid off excepting that on Ponder's End. Then, going to the balance-sheet, they would see that their capital remained intact. This time last year the subscribed capital represented £471,298; it represented it now. The 23,564 B shares represented Mr. Edison's contingent interest. They would see the B shares were entitled to one-fourth of the profits after a cumulative preferential dividend of 7 per cent., and three-fourths of the surplus profits had been paid to the A shares, that was to say, before Mr. Edison or holders of B shares could touch any money they must have 7 per cent. and have paid off this accumulation of £96,630 out of profits. He had a great admiration for Mr. Edison and hoped that very soon he would touch his half proportion of their profits after paying off these arrears. The sundry credit balances stood at £5,799, as against £13,350, and he was very glad to see it reduced. On the other side of the account they saw the reverse picture. The cost of patents, goodwill, preliminary outlay, loss on working, &c., was £305,057, but that went through a process of diminution by writing off and selling plant, which realised an excess in value over and above the value estimated when the business was taken over, and it was reduced to £298,354. The item for "further expenditure thereon" was £4,467 during the year. Lower down in the account they would observe the item for freehold property, less mortgage, was £13,691; installations in progress, £2,794; plant and stock, £30,044—that was a fair valuation of plant and stock, with which they carried on their business, after being written down on profit and loss account in order to meet the depreciation of plant. The office furniture was £1,057, an increase of £100 odd, which could, no doubt, be explained. The debtors' item was £12,946, as against £14,887 last year. These were all good debts and good assets. The cash at the bank was £14,174, as against £8,473. All these totalled together represented the real, tangible assets which, if they were to sell, would be realised in sovereigns; the other meant all they were going to get out of the business in the future. He thought he had been a little exhaustive, but he was reminded that Whiteley's fire was made much worse by reason of gas—that was quite evident. Where a big fire set in and enormous premises like these were filled with gas pipes which were full of gas it became a very serious matter, and this was a danger which did not attach to electric light in at all the same degree. He had no doubt that was a consideration which in course of time would operate upon the people who had to consider this fire question. Then, also, there was the matter of the theatres; everybody knew what a great agitation there had been on this subject. When the fires arose people set to work to see how they could be avoided in future, and he believed they would see theatres in the course of a few years all lighted with electricity. He remembered that when he was a vigorous young man when he went to Covent Garden he had to face an intense glare and endure a suffocating heat. Certainly he would not go now on such terms. He intended to say no more, subject, of course, to being ready to answer any questions, and he now moved: "That the report and accounts be received and adopted."

Mr. F. R. Leyland, the deputy chairman, seconded the motion.

Mr. Prior enquired respecting the legal expenses, Mr. Neale as to the length of time the patents had to run, and Mr. J. H. Rew whether there was not an action pending with the Anglo-American Brush Corporation.

The Chairman, in replying to these queries, said that in the accounts they would see, under "Costs of patents, goodwill, preliminary outlay, &c.—further expenditure thereon," the sum of £4,467 4s. 7d. Nearly all the legal expenses incurred by the company had been in connection with the defence and building-up of the patents, and they had from year to year in that account, costs of patents, &c., debited capital with a certain amount for the purpose of providing a reserve to meet the legal expenses; that reserve had been added to by the amount shown as "further expenditure" on the cost of the patents, goodwill, &c., £4,467. They were capital charges. Some people thought the cost of a patent was what was paid to the patentee, but if after the patentee had been paid, the patent was assailed, was not the cost of defending it part of the cost of the patent itself? That was the view the directors took, and it was the view taken by the auditors. Shareholders need be under no fear that there was a heavy bill for legal expenses yet to come, for they had paid as they had gone along. With regard to the application of profit, they thought they were bound by the dictates of what he would call "public accountant justice" to apply the profit to writing down the losses of previous years rather than distribute them in a dividend. They had put together two concerns which had not been very wisely administered. There had been great faults, very bad bargains had been made, and the plant which was then the plant of the period had since become quite obsolete. They had, therefore, to write down very large sums to losses. Three years ago they lost £28,000 on the working account. In the following year the result of their rearrangement was the turning of the loss of £28,000 into a profit of £12,000, which they wrote down. They proposed to follow the same course now. There was a grave legal question as to whether they could do otherwise, and they had followed the advice of their accountants by applying the money to the improvement of the company instead of taking it now. The patent has six years to run from the end of November next; the key patent, that was, for they had a number of others. They had said in the report—they did not care to accentuate it too much—that other legal suits were pending; but they thought there was no probability of the judgments of the Courts of Appeal being reversed. The Brush Company had gone beyond threats and had now issued a writ. He did not believe in undervaluing an adversary, but he did not think there was much to fear in this instance. The Brush people had a patent which they *thought* Edison and Swan were infringing; this company had a patent which they *knew* the Brush people were infringing. That was the difference. What the Brush Company in their wisdom would seek to do he did not know. He had no desire to embitter their relations with them; they were very persevering people, and were trying to push their trade, but they found they could not do so without using the Edison-Swan lamp. Having explained the position with regard to the Electric Lighting Act and its proposed amendments, the

Chairman put the motion for the adoption of the report and accounts, and it was unanimously carried.

Mr. Shelford Bidwell, F.R.S., the retiring director, and the auditors, Messrs. Quilter, Welton & Co., were then re-elected, and a vote of thanks having been accorded to the chairman and other directors, the meeting terminated.

The National Telephone Company, Limited.

THE seventh annual ordinary general meeting of this company was held on Friday last week at the offices, 11, Queen Victoria Street, E.C., under the presidency of Col. R. Raynsford Jackson.

Mr. Wm. B. Campbell, the Secretary, having read the notice convening the meeting, and the report, which was published in the REVIEW last week, having been taken as read,

The Chairman, in moving its adoption, said: Our report is, perhaps, shorter than usual, and the necessity for dwelling upon it at length is also, perhaps, less pressing than on ordinary occasions. When I addressed you last year I pointed out that there had been a growth in the revenue, and that it had reached the sum of £81,500 per year, including fee messages, and I explained to you that the fee messages were a new and growing source of revenue. They had at that time reached from £800 to £900 a year; they are now £1,800 a year, and are increasing month by month. The total gross revenue for the year to June 30th last was £92,337 2s. 4d. It is still steadily and satisfactorily increasing. As regards the trunk wires, I think it is desirable that I should call your special attention to the part of the report which refers to them. You will see that last year the mileage of trunk lines was 363, and now it is 613; that our mileage of wire upon the trunk lines was 1,216, and now is 1,919. Now, this is a very important fact, because it indicates a very valuable additional service which we give to those who are members of our exchanges. They have the means of communication over a much wider area than they had before, and I am happy to say that they seem to appreciate very highly the additional advantage so given to them. I may state without any reserve that it is our desire to extend that system much further. We expended over £8,000 upon it last year, and we shall in all probability spend a very considerable sum again this year. As I explained last year, our Yorkshire system was connected with the Lancashire and Cheshire system, by arrangement with the Lancashire and Cheshire Company. We are now contemplating no less than connecting our Yorkshire system with the Birmingham, the Potteries, and the Nottingham districts, so that all our English exchanges, excepting those very far north, in West Cumberland, will be in communication with each other. I need not dwell, I think, upon the advantage to the community which will be given by the extra facility which the residents in the towns scattered over our large district will have when they are able instantaneously over that large area to hold conversations with each other at a moderate rate. The increase of revenue for the year, you will see, is somewhat over £11,000, and I may mention that it would have been greater had we not felt it advisable to deal with our tariff in Glasgow. When we started there we bought up several rival companies with varying tariffs, and we thought about a year ago that the time had come to equalise those tariffs. In the process of equalisation, as a matter of course, we lost something. For the year that has passed we received £2,200 less from our old subscribers than we should have done had it not been for the equalisation of the tariffs, and to that extent, of course, the revenue for the year was reduced. I am happy, however, to be able to inform you that the gross revenue from Glasgow is about £1,800 more than it was before we made the reduction. You will see upon the reverse of the report that you will be asked to sanction the issue of £150,000 of what I will call debenture stock. I think that, probably, seeing this on the report was very likely to mislead some of the shareholders as to the intentions of the directors. We have no intention of issuing any of this debenture stock excepting for the purpose of replacing debenture bonds which are now in the possession of the public to the extent of £75,000. The further issue of £75,000 of debentures will be very much delayed, and we do not see any definite period at which there will be any call for it. We have taken the power to issue £150,000, while we only really require £75,000, but if ever hereafter it proves to be desirable to issue a further sum of debenture stock, it will certainly be to the interest of the company if that issue be not in the form of second debenture stock, and it is merely to guard against a somewhat remote possibility that we are asking now for power to issue £150,000. We have no intention to do more than deal with the debenture bonds now in the possession of the public. I do not know that it is necessary for me to detain you by dwelling upon any other topic. I am happy to say that so far our relations with all others with whom we do important business—principally the Post Office and the United Telephone Company—are concerned, they are as satisfactory as hitherto, and that we stand generally on friendly terms with the public who use our telephone system. I have great pleasure in moving the adoption of the report.

Mr. W. A. Smith seconded the motion, and in doing so said he could only corroborate what Col. Jackson had said in regard to the position of the company. He was sure it must be a source of gratification to them all that under Col. Jackson's guidance it had attained the position it now occupied. He would venture to refer to one or two points to which he knew Col. Jackson had intended to advert. He thought he might say without fear of contradiction that the National Company had always led the way in the adoption of every possible apparatus which would facilitate the service given to the public. During the past year everything that could tend to increase their revenue and to give a quicker service to their subscribers had been adopted without loss of time, and he might as an illustration of this advert to the fact that during the year, at a considerable cost, a large portion of the wires had been renewed and reconstructed, and the whole system put into thoroughly good condition, the result being that they were now, as Col. Jackson had stated, on the very best possible terms with their subscribers. As a proof of the soundness of their methods he would only allude to the fact that in a territory extending as far north as Inverness and down as far south as Birmingham, all the snowstorms that took place last year only cost the company a trifle over £600. He thought that in making that statement he said all that it was necessary to say in support of the system which had been promoted by Col. Jackson.

Mr. G. E. Smith, of Nottingham, desired to bring to the attention of the directors a question of wayleaves. He was afraid that in some districts wires had been run and insulators had been put up in certain places without the permission of the owners. On St. Paul's Church in Nottingham—an old church well leaded on the top—holes had been made and a pole erected without the permission of any of the authorities. He had spoken of the matter before in the time of the previous chairman, but the pole still remained. This kind of thing was very detrimental to the company, and he hoped something would be done in the matter.

Mr. John Leake, of Manchester, asked if there would be any objection to dividing the items coming under the heading of "Working expenses for management, operators' wages, office salaries and charges," the total of which was over £19,000, so that the amount of director's fees and the salaries might be shown separately.

The Chairman, in reply, first thanked Mr. G. E. Smith for the remarks he had made and for bringing before the board in so prominent a way a case of negligence, or of disregard of orders, assuring him that they would do their best to remedy this particular grievance and to prevent any similar occurrences. It was their desire that their staff should treat householders and all others with whom they had to deal with courtesy, and that they should not claim rights over property which they could only exercise, morally or legally, with the consent of the proprietors. With regard to the query of Mr. Leake, they had no objection to make a further sub-division of the items in the accounts in future. As Mr. Leake had mentioned the directors' fees, he might state that they amounted to £1,000 per annum. They desired to make no reservation, but to give all the information that it would be advantageous to the company to give.

The motion for the adoption of the report and accounts was then put and carried unanimously.

The Chairman moved "that a dividend at the rate of 6 per cent. per annum, less income tax, be paid upon the first preference stock for the six months to June 30th, 1887;" "that a dividend at the rate of 6 per cent. per annum, less income tax, be paid upon the amount called up on the second preference stock for the six months ended June 30th, 1887," and "that a dividend at the rate of 4 per cent, per annum, free of income-tax, be paid on the ordinary stock for the six months ended June 30th, 1887." These motions were all unanimously agreed to.

The retiring directors, Mr. Peter Garnett, of Thirsk, Yorkshire; Mr. J. F. Harrison, of Rawdon, Yorkshire; and Mr. S. H. Sands, of Nottingham, were re-elected, as also were the auditors, Messrs. Quilter, Welton & Co.

The Chairman said the next resolution he had to propose referred to the subject with which he had already dealt in his previous remarks, that was, the subject of the debentures. He moved: "That the directors be authorised to borrow, for the purposes of the company, such sums of money as they may think proper, but so that the amount borrowed shall not at any one time be greater than £150,000, and that all moneys so borrowed may be represented by debentures, debenture stock certificates or otherwise, and may be payable or redeemable in such events and secured in such manner and generally may be issued on such terms as the directors may think fit."

Mr. Begg seconded the motion, which was carried.

Mr. W. W. Cargill said he had attended every meeting held by this company since it was established, and at each meeting he felt greater satisfaction with the way in which the business was conducted. What the chairman had said with regard to the position and prospects of the company was just as satisfacfory as his statements had always been, and he had no doubt the shareholders would join him in a vote of thanks to Col. Jackson and the rest of the board.

Mr. Leake seconded the vote, which was cordially agreed to.

The Chairman, in returning thanks, said the board had always had the assistance of the shareholders wherever the company was working, and in many cases their assistance had been very valuable.

The meeting then terminated.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 5th were £2,791, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for July, 1887, £25,400; from January 1st to July 31st, 1887, £160,550; corresponding months, 1886, £147,500; and of 1885, £168,040.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

5817. "Improvements in galvanic batteries." S. F. WALKER. Dated April 29. 4d. Relates to the battery already described in the REVIEW.

7478. "Improvements in electric lamps." S. P. THOMPSON. Dated June 3. 8d. Claims:—1. In an electric arc lamp the application to the feeding or regulating mechanism of an electric device, in which a series coil and a shunt coil act jointly, so as to produce an attractive force proportional (or approximately so) to the product of the current in the one into the difference of potential at the terminals of the other. 2. In the feeding or regulating mechanism of an electric arc lamp, the combination of an opposing spring or a counterpoise weight with an electric device, in which the attractive force is proportional (or approximately so) to the product of the two currents passing respectively in a coil in series with the arc and in a coil in shunt with the arc. 3. The arrangements illustrated by the drawings, for the purpose described.

7919. "Improvements in and connected with incandescent electric lamps." R. KENNEDY and R. DICK. Dated June 12. 8d. Relates to the invention recently described in the REVIEW.

1887.

168. "Improvements relating to electric regulation and to apparatus therefor." C. L. R. E. MENGES. Dated January 5. 8d. The improved method of regulation is more particularly designed to regulate irregularities resulting from sudden changes in the external circuit. The claims are 9 in number.

886. "An electric heat-detecting alarm." J. ADAIR. Dated January 20. 6d. Claims:—1. The introduction of a material that will melt with heat as a means of obstructing and discontinuing an electric current and the melting of such material as a means of permitting and continuing such electric current, and the making use of this means as a heat-detector, after the nature as described in the invention. 2. The expansion of a material as a means of permitting and continuing an electric current which before such expansion was obstructed and discontinued and the making use of this means as a heat-detector, after the nature as described in the invention. 3. The methods of using a material that will melt with heat, or expand with heat, as described in the invention.

1393. "Improvements in underground conduits for electrical conductors and means for distributing the conductors therefrom." A. J. BOULT. (Communicated from abroad by J. F. Munsie, of America.) Dated January 28. 11d. The object of this invention is to provide within an underground conduit system for electric conductors means by which the wires or cables extending through each duct of such system may be distributed for operative purposes to the best possible advantage. It further relates to new forms of underground electric conduits, and to means for hauling the wires therethrough, and to other improvements in the general and specific arrangement and structure of underground electric conduits and distributing stations and their adjuncts, as described. The claims are 14 in number.

1400. "Improvements in automatic apparatus for subjecting the person to the action of electric currents." A. LOISEAU and O. PIERRARD. Dated January 28. 8d. In the specification to an application for letters patent, filed by the inventors on October 8th, 1886, No. 12,833, they described an automatic apparatus for subjecting the person to the action of electric currents, wherein, a person placing himself on a stand and introducing a coin into the apparatus, effected the closure of certain electric circuits, some of which served to bring certain parts of the apparatus into position for rendering the apparatus operative, while another circuit served to bring the electrifying devices into action. According to the present invention they effect the bringing of the parts into position for operating and for controlling the duration of the electrifying current by mechanical means instead of by means of electric currents, the only electrical circuit employed being that required for exciting the electrifying apparatus. The claims are 3 in number.

1527. "Autographic telegraph." H. J. ALLISON. (Communicated from abroad by The Writing Telegraph Company, of New York.) Dated February 1. 8d. In former patents, the inventor has described means for varying the current in an electric circuit in autographic telegraphs, in which the strength of the current is altered by varying the pressure on a pile of carbon discs included in the circuit, the strength of the current being gradually changed. The extent of surface of the discs in contact is governed in that case by the varying pressure brought to bear upon them, and the resistance is varied accordingly. In the present invention the same effect is obtained by immersing one electrode to a greater or less extent in a liquid constituting part of the other electrode; also by the electrodes being brought nearer to, or farther away from each other; also by both actions combined. The claims are 12 in number.

1570. "Improvements in circuit closing apparatus for electric brake and other circuits." E. E. RIES. Dated February 1. 8d. Relates to certain improvements in circuit closing apparatus, whereby the actuating current to the brake or other devices is applied gradually and with continuously increasing strength, so as not to subject said devices to the rapid wear and tear due to the sudden strain upon them when, as has heretofore been customary in operating such apparatus, the entire strength of the current is applied at once. It further relates to certain improvements whereby the amount of current supplied to the brake or other devices can be regulated and controlled at will, so that the operation of such devices and the extent to which they are applied, is at all times under perfect control. The claims are 19 in number.

1584. "Improvements in electric signals for engines." J. C. RICKETSON. Dated February 1. 8d. Claims:—1. The combination of a reversible engine with a distant signal, a push button electrically connected to said signal, and a series of bell-crank levers connected together, and adapted to be actuated by one of the eccentric rods of the engine, whereby the movement of said rod will automatically make contact with the said push button, and thereby actuate the signal. 2. The combination of a reversible engine with two distant signals, push buttons electrically connected to the latter, and two series of bell-crank levers, one lever in each series being located adjacent to each of the eccentric rods of said engine, and another of the levers in each series located adjacent to each of the said push buttons, and all the levers in each series being connected together, whereby, when either eccentric rod strikes against its adjacent lever, all the levers in that series will be moved and the last lever of said series will come in contact with its adjacent push button, and hence will thereby automatically actuate that signal with which the latter is in electrical connection.

1656. "Improved apparatus for preventing the escape of noxious fumes or other gases from primary, secondary, gas, or other batteries used for electrical purposes." M. BAILEY and J. WARNER. Dated February 2. 8d. The claims in this specification are 8 in number.

1750. "Improvements relating to the electro-deposition of aluminium and to apparatus therefor." H. H. LAKE. (Communicated from abroad by the Count Rudolphe de Montgelas, of Philadelphia.) Dated February 3. 6d. Claims:—1. Electrolytically plating with aluminium in a pure metallic state from a neutral aqueous solution of double chloride of aluminium and sodium, substantially as set forth. 2. In an apparatus for electroplating with aluminium, an anode of aluminium and an electrolytic liquid, consisting of a neutral aqueous solution of double chloride of aluminium and sodium, substantially as described.

1752. "Improvements relating to electric batteries." H. H. LAKE. (Communicated from abroad by the Count Rudolphe de Montgelas, of Philadelphia.) Dated February 3. 6d. Relates to a galvanic cell in which the positive or non-attacked element is of aluminium, and consists in the construction and arrangement of said cell. The claims are 3 in number.

2079. "Improvements in means or apparatus for controlling telephonic communications." J. GILL. Dated February 10. 6d. Claims:—1. The means employed for the liberation of a sliding bar by the deposit of a coin, token, or voucher in the box, substantially in the manner described. 2. The locking of the sliding bar by a projection, substantially in the manner shown and described. 3. The sliding bar combined with a spring, substantially in the manner and for the purpose shown and described. 4. The combination of a recessed lever with the sliding bar and a lever with a projection, substantially in the manner and for the purpose described.

2377. "Improvements in electro-magnetic brake systems." G. F. CARD. Dated February 15. 1s. 1d. Comprises a normally closed metallic circuit whose couplings between the several component vehicles of the train are such as, when joined, to present insulated conduits for the outgoing and returning currents respectively and such as, when separated, to automatically complete the circuit at the point of rupture on each separated portion. The specification includes a description of such coupling. Such circuit further includes two distant storage batteries of equal but oppositely directed electromotive forces, causing a condition of electrical equilibrium and consequent inaction in the normal condition of the circuit. The said circuit includes, on each vehicle composing the train, a customary or any suitable electro-magnetic apparatus adapted to dominate the brake mechanism proper of each individual vehicle. The specification describes a form of such apparatus, such as preferably employed by the inventor. Each battery in the system is accompanied by a current regulating apparatus, whose construction is such as to enable discretionary brake action of an unbroken train and such also as to cause the brakes on each portion of an accidentally separated train to be automatically set and yet to be capable of subsequent regulation or withdrawal by a train man on such separated portion. The claims are 17 in number.

CORRESPONDENCE.

Platinoid.

In the ELECTRICAL REVIEW of June 24th (pp. 594 and 595), you have a paper by Prof. Anthony read before the American Institute, "On the differing temperature coefficients of the different coils of a fine

rheostat," and you reprint the discussion which followed. In the course of the latter Mr. Prescott referred at some length to investigations made by Mr. Weston into the subject of platinoid.

The method of investigation pursued by Mr. Weston appear to some of us who are interested in this new alloy to be very curious, as well as the conclusions he arrived at. Mr. Weston seems to have read Prof. Bottomley's paper on the subject (a paper detailing the specific results of careful and continued experiments) and to have resolved to start an independent investigation of his own. The method of procedure which we presume most people would have adopted, would have been to get some platinoid from the patentee and subject it to whatever chemical or electrical test might be thought desirable to discover its nature and properties. This, however, was not Mr. Weston's method. He thought he would make some platinoid for himself, and accordingly he mixed up what he understood to be the ordinary ingredients of German silver and threw some tungsten into his melting pot. Then he felt quite satisfied that he had got platinoid. In point of fact he had not made platinoid at all. The alloy he had made possessed a high resistance no doubt, but it did not possess the quality which chiefly distinguishes platinoid.

For many years metallurgists have been experimenting with tungsten, but no one could ever get it to mix with other metals (except with iron) until Mr. F. W. Martino, of Sheffield, (whom Mr. Prescott calls a "Cheshire man") discovered the right way of doing it. All other attempts, Mr. Weston's among the rest, have been unsuccessful. Tungsten has been thrown into the melting pot in a multitude of combinations, but the alloy which has come out has invariably shown the particles of tungsten, separate and distinct from all the other ingredients, just as felspar can be picked out from everything else in a block of Aberdeen granite. It was Mr. Martino's invention to discover what was wanted in order to make tungsten mix perfectly with other metals, and in the end he produced a certain definite alloy, containing a specific proportion of tungsten, and which he patented under the name of platinoid.

The peculiar value of platinoid lies in its density, a property imparted to it by the amalgamation of tungsten. As one result of its density platinoid has this enormous advantage over every other metal and alloy (excepting gold and platinum) that it will not tarnish under atmospheric influences. The importance of this property cannot be over estimated, and is being more and more appreciated by the electrical engineers who have used it longest.

In the discussion amongst the American electricians mention was made of the great diversity of different samples of German silver. Mr. Wallace said:—"There are all sorts of mixtures in the market, and it does not surprise me at all that you do not get two samples alike." This is perfectly true in England as in America, as those of us have found who have maintained a uniform standard and have had to face the competition of German and French makers.

In the case of platinoid, however, there can be but one quality. What it is found to be to-day it will be next year. It will neither tarnish nor disintegrate nor vary, to any appreciable extent, with the variation of temperature. Its specific resistance is almost exactly the same as that of platinum silver, about one and a half times that of the best German silver. These were the results arrived at two years ago by Mr. Bottomley at Glasgow. Dr. Fleming has since published similar results from his own experiments, and many electrical engineers who have used it, some of them largely, have arrived at the same conclusions from the experience of executed work.

We are induced to trouble you with this note through seeing how speedily Mr. Weston's hasty and ill-considered conclusions seem to have been accepted on this side. Mr. Swinburne, in his admirable series of papers on "Practical Electrical Measurement" says, in your issue of the 1st July (p. 10), "The alloy known as platinoid is, according to Mr. Weston, simply German silver with a large proportion of nickel, the slight addition of tungsten having no effect." But that was Weston's home-made platinoid, not Martino's.

The London Electric Wire Company.

9th August, 1887.

[The paper referred to by our correspondent is that entitled "On the Electric Resistance of a new alloy named Platinoid," by J. T. Bottomley, M.A., F.R.S.E., and it was published in the ELECTRICAL REVIEW for July 4th, 1885.—EDS. ELEC. REV.]

"The Calibration of Measuring Instruments."

The table of readings from seven voltmeters given by Sir Thomas Bazley in your issue of July 29th, p. 127, is at once instructive and humiliating. The makers of the instruments tested ought to feel grateful to Sir Thomas for the very considerate way in which he has exposed their errors: yet not one of them writes to thank him! I have reduced the errors given in the table to percentages, and in the annexed table I give the average error of each voltmeter over that portion of the scale included in Sir Thomas Bazley's table. It appears there is a difference of opinion among the makers as to the probable value of the volt to the extent of 6½ per cent. It is true that a standardising institution might remedy this, but alas! the wicked volt accounts for only a part of the evil; there are still the purely *instrumental* errors to be dealt with, and to show how very serious these are I give in a second line the difference between the maximum and minimum percentage errors of each voltmeter. I call this the "maximum instrument error." As in some sense a measure of the care (?) with which these instruments have been constructed and calibrated, I have inserted the average instrument errors. Apparently only one of the seven is worthy of the name voltmeter.

I must not be understood as wholly condemning the makers (indeed, I suspect I am myself responsible for some of the instruments). As a fact, scale errors are often almost unavoidable in instruments whose laws are complex; mechanical friction also is a fruitful source of error in nearly all instruments, but the maximum *instrument* error from all causes ought never to exceed 1 per cent. over the useful part of the scale.

I will, with your permission, reserve for another issue some remarks on a "standardising laboratory" and the variable volt.

Voltmeter.	A	B	C	D	E	F	G
Average error per cent.	− 2·6	± 1·3	− 0·5	− 1·6	+ 6·4	− 1·2	+ 1·5
Maximum instrument error per cent.	1·7	4·4	0·7	1·6	3·0	2·0	1·1
Average instrument error per cent.	0·9	1·8	0·3	0·6	1·6	0·9	0·6

Sydney Evershed.

August 19th, 1887.

Erecting Telephone Lines.

I desire to ask your opinion and for full information (if you will kindly furnish me with same), as to the following matter:—I have run a telephone line (private), and have crossed certain property in town—a warehouse, not a garden or pleasure ground—and the owner of the said property has threatened me that he will cut down the line; although my men have not been on his premises and the wire is some 18 or 20 ft. above the property. Can he cut it down? I told him if he required to build up to it I would then remove it, and he declines to come to reasonable terms. Am I obliged to run the wire clear of his property, or can I claim damages if he should cut it down? and will he

be responsible for damages if any result from his so cutting down the wire?

E.B.F.H.

[Conflicting decisions have, we believe, been given, and the law upon the matter is not at all clear. We should think, however, that if you can prove that you have sustained loss as a consequence of the cutting of the wire you could recover damages.—EDS. ELEC. REV.]

The Blackpool Tramway.

Your article on the breakdown of the Blackpool electrical tramway is somewhat misleading, inasmuch as the insulators themselves are solely at fault. These insulators I supplied to specification when the line was built, and, although I had my opinion as to their practicability, it was not my business to interfere. However, the cemented iron studs have not only split a great number of the insulators, causing serious leakage, but have almost corroded away at the main point of support. My firm has been entrusted with the work of making an entirely new form of insulator, of my own design, and which will, I think, overcome the whole difficulty and make the system, what it was before the old insulators failed, a very successful one.

J. Slater Lewis.

Britannia Telegraph Works, Helsby,
Cheshire, *August 9th*, 1887.

I have only to-day seen your leading article in the ELECTRICAL REVIEW of August 5th; from it I find that though I was requested to keep things as quiet as possible "for the good of the company," a version has been given you, and I therefore hasten to send you a copy of my report to the directors relative to an inspection made on the 22nd June, and regret very much that I complied with the request made me and withheld it so long.

M. Holroyd Smith.

August 9th, 1887.

[COPY.]

Royal Insurance Buildings, Halifax,
June 27th, 1887.

Gentlemen,—On the 22nd inst. I received the following letter and telegram from Mr. James Broadbent, managing-director of the Blackpool Electric Tramway:—

"*June 21st*, 1887.

"Mr. M. H. Smith.

"Dear Sir,—Will you please come over here by the first train you can get. We have had to stop two days together in the heat of the day; all our power is going and we cannot move along, we think it is the expansion of the tubes with the excessive heat. Please come at once, and oblige

"Yours truly,
"JAS. BROADBENT."

Telegram.

"All cars stopped, come at once.—BROADBENT."

I went by the 1.20 p.m. train, and on arrival at Blackpool found as above stated that the cars were stopped. I met Mr. Broadbent at the shed. He told me that everything was right at the engine house, and that the fault was in the line.

The Wheatstone's bridge and galvanometer used for testing conductivity and insulation have evidently not been made use of for some time, and were not in proper working order.

I had considerable difficulty in taking any readings owing to the multiple switchboard having been removed, and no substitute for measuring purposes being provided. [See note B.]

I was informed that none were ever taken. The voltmeter and ammeter were still in position and means provided for taking readings from them, but having no opportunity of examining the coupling I have to assume they were correctly made, and believe them to be so.

These instruments require periodical correction. No test since that of Major Armstrong, on behalf of the Board of Trade, has ever been made to my knowledge.

The measurements I took with the Wheatstone's bridge and galvanometer when calculated did not agree with the voltmeter, but showed it to be indicating less than the actual E.M.F.

I asked for the "detector," a small instrument for use on the line, and when produced found it to be without battery. One of the men occasionally uses it with the aid of one of the accumulators for lighting the car; this is not only heavy and troublesome to carry about, but is a risky proceeding. It was therefore impossible for me to make tests upon the line itself, even had I been given an opportunity of doing so.

The cars could not work because of the enormous leakage of electricity throughout the line, due to defective insulation.

As the weather was, and for some time has been hot and dry, such a condition ought not to exist.

Mr. Broadbent attributed it entirely to bad insulators, and I was informed that during the winter many of them cracked "through the frost" and had to be removed. Mr. Lancaster said *that they had taken out* 30, 50, *and as many as* 90 *a day.*

On enquiry if they had been replaced with new ones, "*No, not all, we have put in some when we had time.*"

"When you remove an insulator, *do you take out the iron stud?*" "*Not always.*"

Mr. Broadbent said that now *they replaced every other one.*

On a portion of the line near Carter's saleroom, where some of the men were working, *I noticed five yards of tube without support, the tube was touching the bottom of the channel.*

Without removing the surface of the channel throughout its entire length it is impossible to speak positively, but I am strongly of opinion that *in many places the copper conductors are "making earth" by touching the side or bottom of the channel* themselves, or *by means of some old insulator studs left in, when the insulators were removed.*

It is much to be regretted that *the renewal of insulators has not been more systematically done.*

The rapid failure of insulators since the line passed out of my control, or the supervision of an electrician, needs explanation.

In the paper read by me before the British Association last year, descriptive of the Blackpool line, I there state that the *electromotive force* usually employed *is* 220 *volts.*

"The average working loss through leakage may be taken at 25 ampères, which at an electromotive force of 220 volts is equal to 7·2 horse-power. At the commencement much trouble and annoyance resulted from the faulty construction previously referred to; but now, by watchfulness and adjustment, any hindrance to working can be avoided."

I adopted *the E.M.F. of* 220 *volts* because I considered it the limit to which it was safe to go.

When the rails are permitted to get very dirty, it is difficult, with this potential, to send sufficient current into the cars to make them run quickly.

I found a much higher voltage had been used, probably to force the current through the dirt.

The voltmeter in the shed *on Thursday indicated over* 270 *volts,* and as before mentioned I believe it to be indicating below the mark, my calculations, assuming the Wheatstone bridge to be correct, made the *E.M.F. to be over* 300 *volts.*

I was informed that it had been the practice to employ this high E.M.F. since last autumn.

I would draw special attention to the fact that the Board of Trade limit the E.M.F. to 250 *volts.*

I have no hesitation in saying that the *destruction of insulators* is mainly due to the *excess of electrical potential.*

The ammeter indicated *a loss of over* 130 *ampères,* this means a waste of more than 50 *horse-power.*

The danger has been further illustrated by the *destruction of coils in the armature of one of the generating dynamos;* such an event did not occur when the E.M.F. of 220 *volts was employed.*

Again referring to my "paper" I there state:—

"*Extra currents would have a tendency to destroy insulation* and would be otherwise injurious."

On Wednesday night Mr. Broadbent instructed the men at 5 o'clock in the morning to flood the line with *salt water,* then to start the dynamos, and where they saw the road smoke, indicating a faulty insulator, to dig it out. I questioned the prudence of this course, the consequences are predeterminable, for assuming an insulator to have *a slight flaw, if it fills with salt water, and a strong current is rapidly forced through it, the sudden heat generated will crack the insulator and make it useless.*

If this method of detecting faulty insulators be used at all, *fresh water* should be employed, and the engines be run slowly, sending a small current of low potential.

Mr. Broadbent wished me to give him an idea as to how to remedy the defects, and I described, as well as I could, a means for doing so, and upon his instructions have prepared models to illustrate the same, which I shall be pleased to submit to the directors at any time.

I consider it absolutely necessary that the line be re-insulated as soon as possible, as a breakdown in the height of the season fast approaching would be most serious. The re-insulation can be done without hindrance to traffic.

I am, yours obediently,
M. HOLROYD SMITH.

Note.—It was suggested that the stoppage was due to expansions; on this point I again refer to my "paper." "The tubes are connected one with the other by wedges made of drawn brass, exactly fitting the inside of the tube. Space is left between the ends to allow for expansion and contraction, and the wedges are secured from shifting by a wrapping wire."

I found upon enquiry that when these wedges have been removed to "break connection," a process frequently necessary, the "wrapping with wire" has been neglected.

Note B.—Extract from paper: "Though a multiple plug switch is somewhat too complicated for ordinary workmen, it forms in the hands of an experienced electrician a perfect means of regulating the direction of the currents from the two generators through the various instruments, and to and from the line. A little watchfulness is necessary, especially before running both machines at the same time, as they have occasionally changed their polarity."